An Update on Mobility in Today's Internet

Geoff Huston,
APNIC Labs
November 2015

Why?

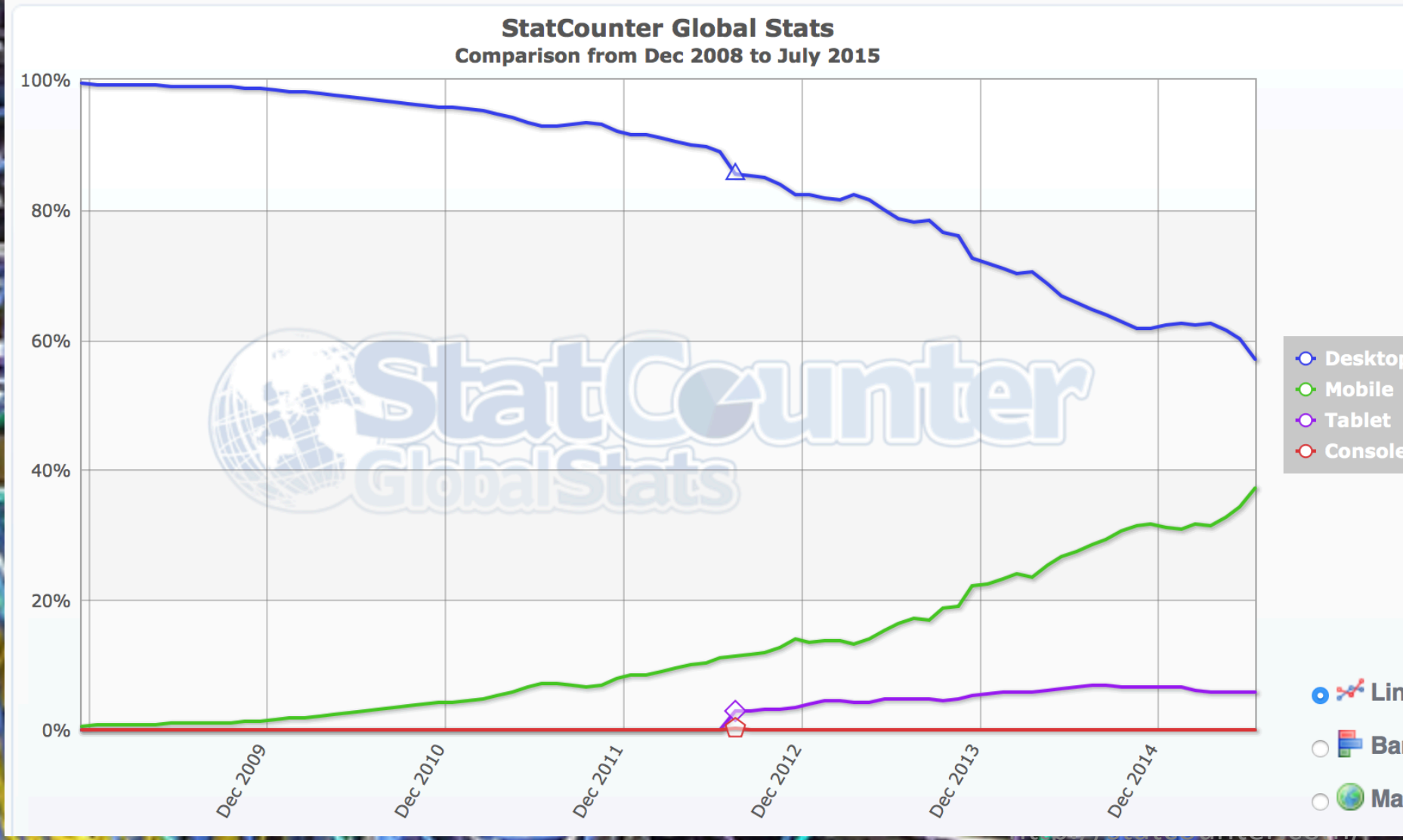
Why should we be concerned about the mobile Internet environment?

Why?

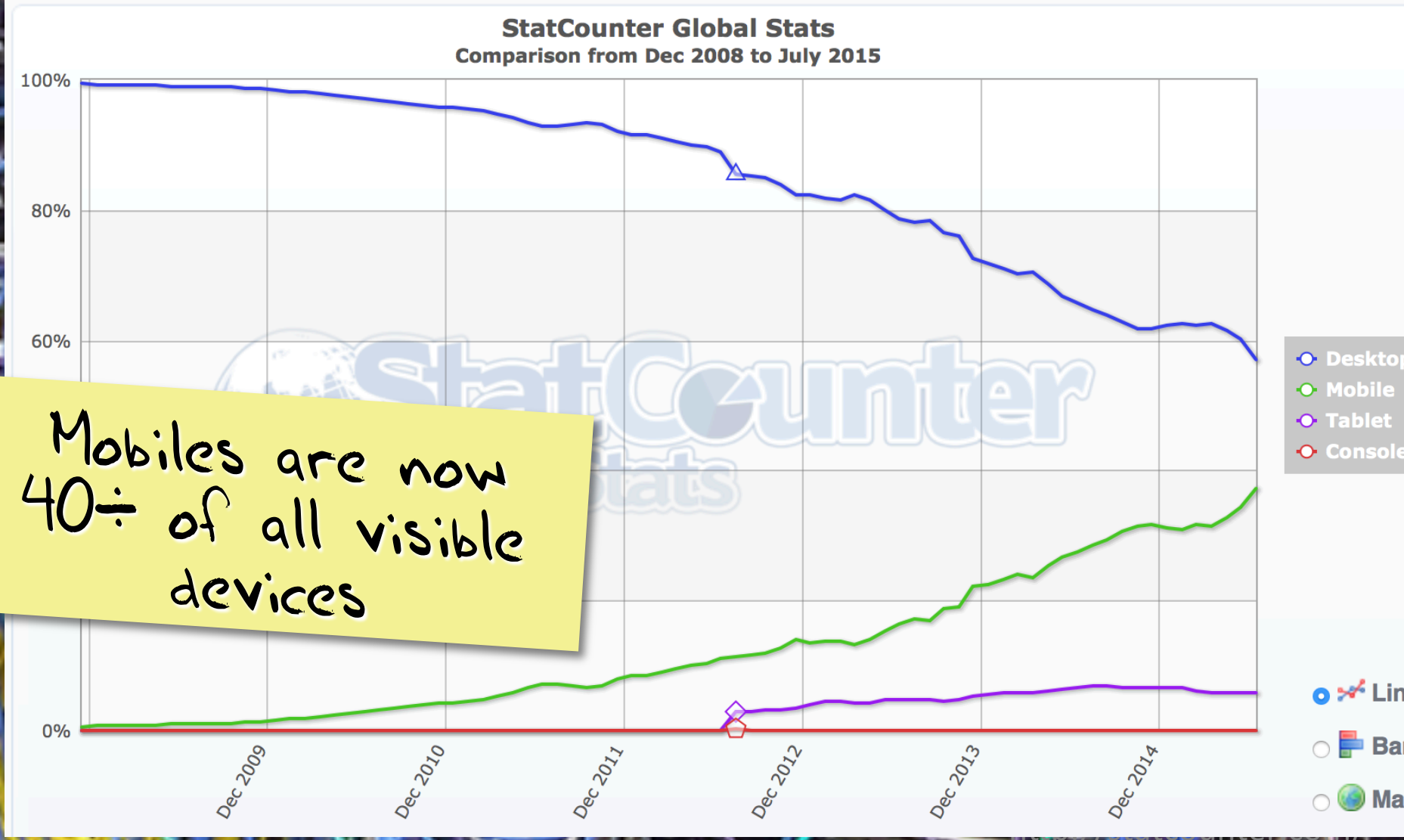
Why should we be cons[illegible] the mobile Internet envir[illegible]

Because everybody else is!

Counting Platforms

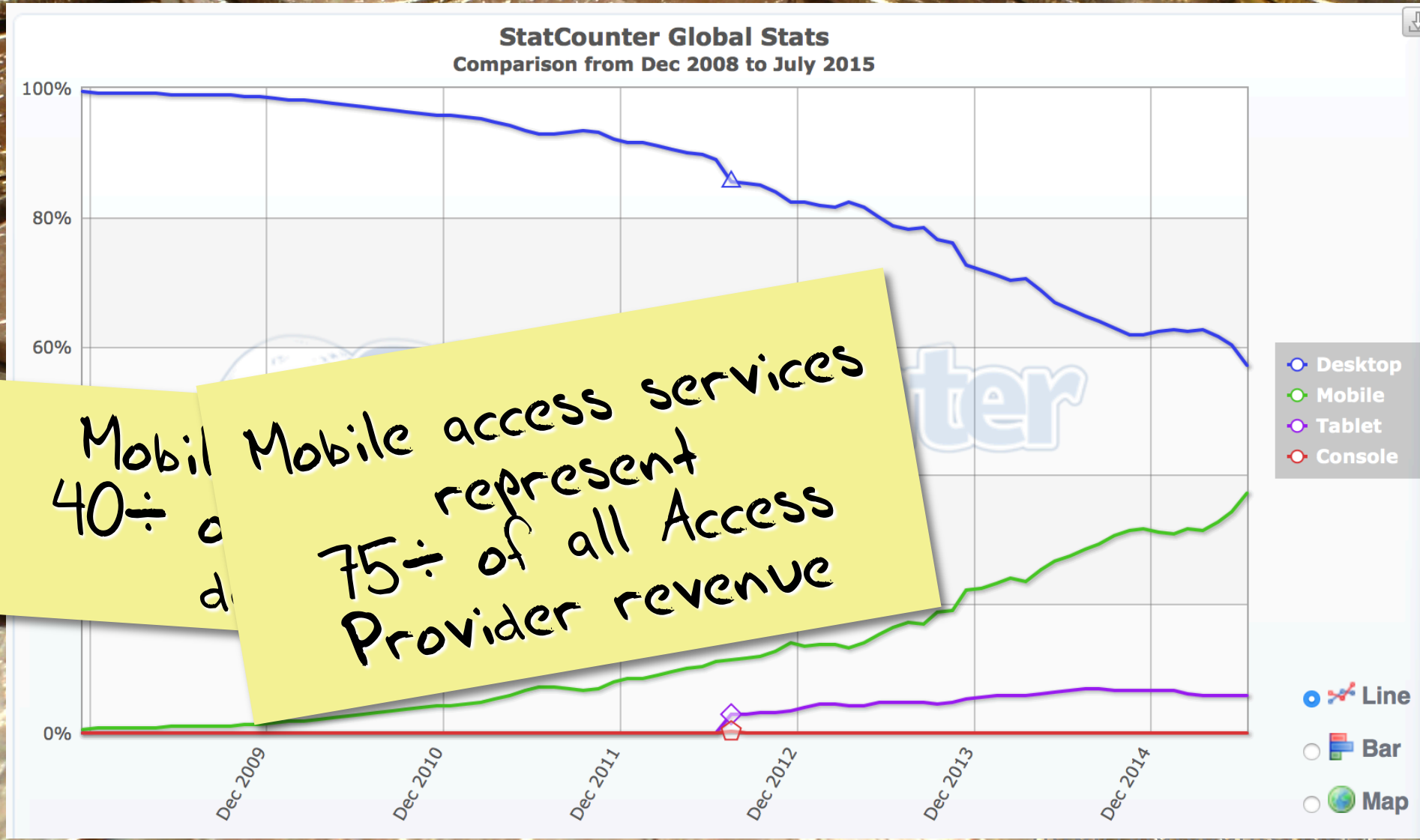


Counting Platforms



Mobiles are now 40÷ of all visible devices

Counting the Money



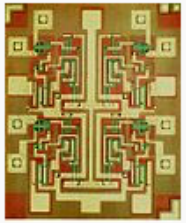
Mobile Production Numbers

2014: 1.5 billion units shipped

Factors:

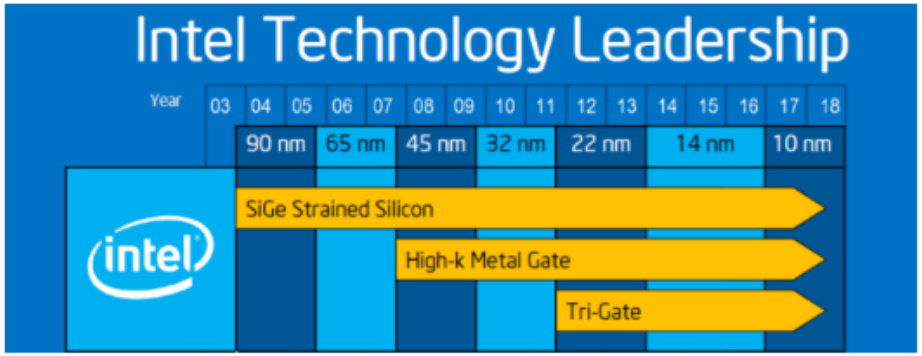
- Production volumes are bringing down component unit cost (unit fabrication cost is close to USD 50)
- Android is bringing down software unit cost
- No need for new content - leverage off the the existing web universe of content
- Shift away from the desktop and the laptop by the chip production industry seeking new markets for their production capability

Semiconductor manufacturing processes



10 μm – 1971
6 μm – 1974
3 μm – 1977
1.5 μm – 1982
1 μm – 1985
800 nm – 1989
600 nm – 1994
350 nm – 1995
250 nm – 1997
180 nm – 1999
130 nm – 2001
90 nm – 2004
65 nm – 2006
45 nm – 2008
32 nm – 2010
22 nm – 2012
14 nm – 2014
10 nm – *2016-2017*
7 nm – *2017-2018*
5 nm – *2020-2021*

Intel will reportedly bring new chips to market based on the company's upcoming 10nm process technology in early 2017. The news came via Taha Khalifa, Intel's general manager for the Middle East and North Africa region.



We've reported three weeks ago that Intel expects to roll-out 14nm Skylake parts in the second half of the year. We've also exclusively told you that Intel's 10nm process technology will not show up in 2016. It's becoming increasingly difficult every year to keep up with Moore's law. The majority of Intel's market segments have been stuck on 22nm for three years, despite Intel's Tick Tock strategy. 14nm is poised to span a similarly extended life cycle to 22nm.

It's usually Intel that leads the way with the latest processor innovations, but today an IBM-led consortium has leapt ahead by announcing it has produced the world's first functional 7nm node test chips. The most advanced commercial CPUs of today are built using a 14nm process and there are plans afoot for 10nm chips in 2016, but shrinking manufacturing any further has proven challenging and not at all straightforward.

"7nm node has remained out of reach due to a number of fundamental technology barriers," says IBM, with the most notable among them being the material properties of silicon itself. IBM's group of collaborators, which includes Samsung and the SUNY Polytechnic Institute, replaced pure silicon with a silicon-germanium (SiGe) alloy for the channel transistors to improve electron mobility at that minuscule scale. It also employed Extreme Ultraviolet (EUV) lithography to etch the microscopic patterns into each chip.

Home › Samsung › Samsung to Start 10nm Chip Production in 2016

SAMSUNG

Samsung to Start 10nm Chip Production in 20

By **Aamir Zubair** - May 26, 2015 1

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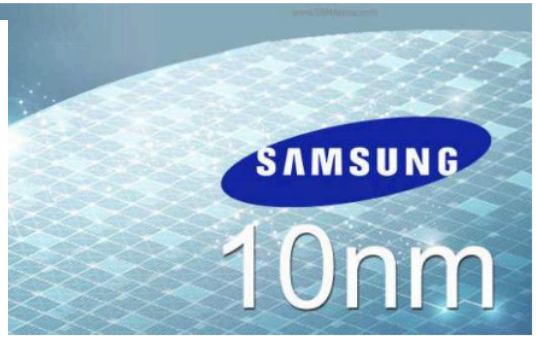

after Samsung unveiled its 14nm process, the company has now unveiled n 10nm FinFET node.

mention about the **specifications** but stated that the process node will be by the end of 2016.

nm process will offer a significant power, area and performance will target many different markets as stated by Hong Hao the foundry's dent.

iness Strategies CEO Handel Jones stated that this is one of the biggest istry in the past few years and it will show that Samsung is a company that sive goals.

Now Apple will also play a very crucial role in determining the 10nm leader because of its massive wafer volumes according to Jones.

Apple is known to order around 40,000 wafers every month and this will help fill a fab but will also require $8 billion in capital expenditures from a chipmaker.

Furthermore it is being expected that the South Korean giant will be making Apple's iPhone 7 SoC in its 14nm process. Jones also mentioned that the South Korean giant has a much higher probability of getting Apple's 2016 and 2017 business in 10nm.

Jones also stated that the only customer that will really drive high wafer volumes in Apple.

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126 Subscr
300 Follow
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Who's playing

Android

- 84% of all smartphone shipments in 2014
- Multi-vendor adoption
- Android also extending into tablets and large screens

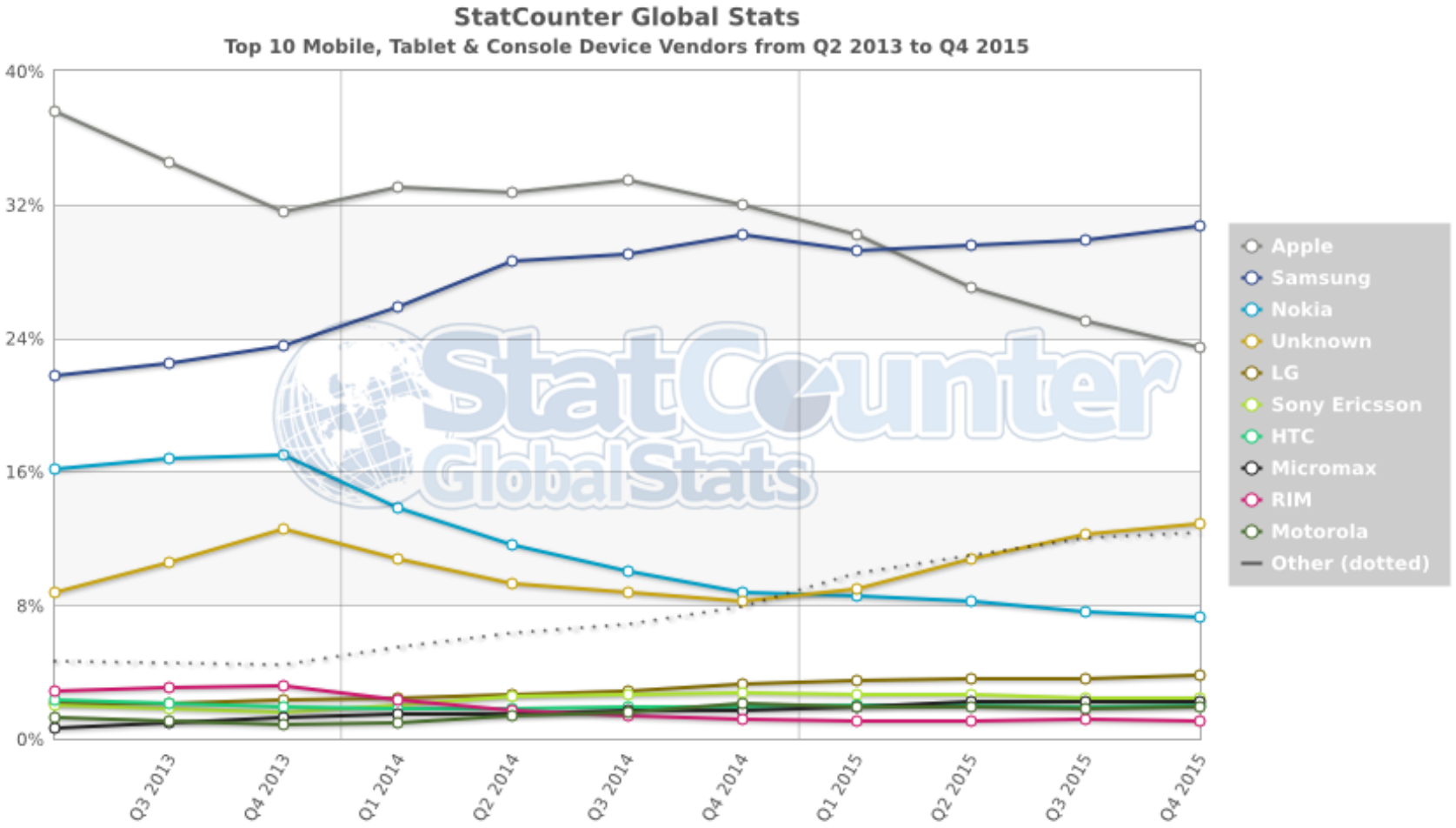
Apple iPhone / iPad

- 12% of all smartphone shipments in 2014
- Revenues for Apple: $182B in 2014

Windows

- 3% market share
- Mostly Lumia models with Nokia

Device Market Share



One Mobile Technology?

- GSM revolutionised the mobile industry by offering a single technology standard and a single business model across a large part of the mobile market
- Roaming just worked in the GSM world
- Has the mobile industry managed to stay in lock step as it moves into the 4G world?

One Mobile Technology?

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- Roaming was unlocked in the GSM world
- Has the mobile industry managed to stay in lockstep as it moves into the 4G world?

Ha! In your dreams!

One Mobile Technology - Not!

The mobile industry is now **very** heterogeneous

- Various spectrum allocations and regulatory constraints
- Various service objectives
- Various operator business objectives (incumbent vs challenger)
- Radically different objectives from handset suppliers vs network carriage operators
- 4G services largely share only the name “4G” – the rest is more random!

Who's in control? Mobiles!

The mobile market is the market "driver" for Internet technology:

- The PC and laptop market is in terminal decline
- Mobiles represent the highest revenue sector, and show the highest growth numbers
- The mobile Market was born and raised on NATs
  - The IPv4 model for cellular mobile service is still heavily based on CGNs and a liberal dose of application level proxies and gateways

Implications for IPv6

The true driver for IPv6 adoption in the Internet is in the mobile sector

- If mobile platforms went to IPv6 then everyone else would be forced to follow!
- So what can we say about IPv6 and mobiles?

The Mobile IPv6 Story

The approach to IPv6 transition is highly fragmented across the operators and across handsets

- IPv4 access network
  - tunnel IPv6 in a conventional (or unconventional) 6-in-4 encapsulation
- IPv6 access network
  - Used in 464 XLAT:
    - Translate V4 into V6 across the access network and reverse translate in the device to present IPv4 interface to applications
  - Advocated by Apple:
    - Translate V4 into V6 across the access network (with support of DNS64) and present IPv6 interface to applications
- Dual Stack access network

The Mobile IPv6 Story

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Which implies the imposition of cost and complexity for the service operators through customization of technologies

- access network and reverse
- device to present IPv4 interface to applications

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The Mobile IPv6 Story

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Nobody wins from this fragmented transition scenario!

– Dual Stack access network

Translate V4 into V6 across the access network (with support of DNS64) and present IPv6 interface to applications

Mobile Devices and IPv6

iOS

- Until iOS 9 there was no OS preference for IPv6

  iOS used a mechanism that was meant to result in an approximate 50/50 split between IPv6 and IPv4 for dual stack

- Browsers and other apps may add their own IPv6 selection bias on top of the OS library

Mobile Devices and IPv6

iOS

Measurement:

– We saw in August 2015 1,216,594 iOS devices accessing Dual Stack services

64,740 responded in IPv6 (5% of seen iOS devices)

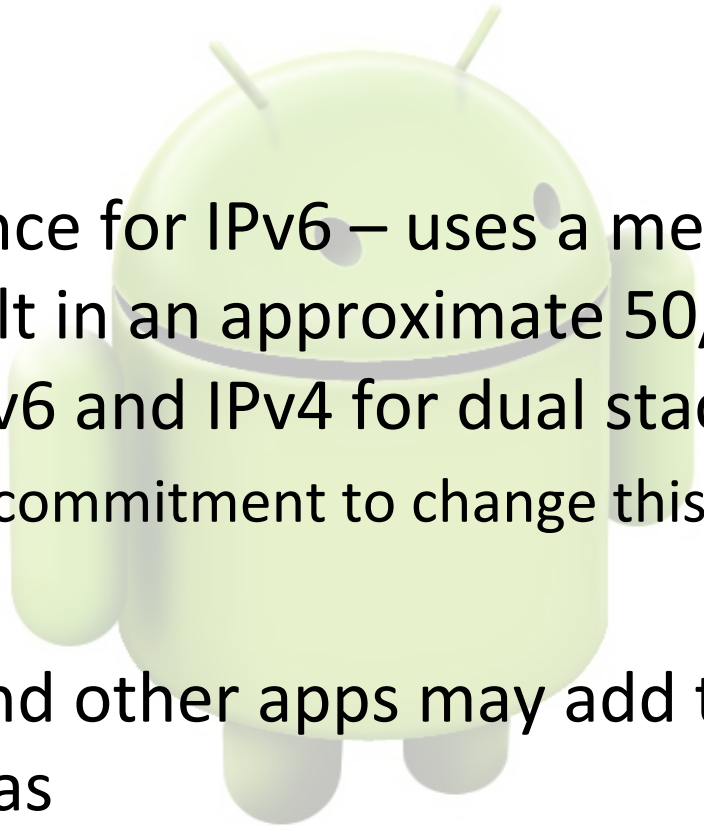
46,784 preferred to use IPv6

Mobile Devices and IPv6

iOS

- iOS 9 changed this behaviour to prefer IPv6 in dual stack contexts
  - iOS 9 is reported to use a 25ms bias timer
- No currently planned support for 464XLAT in the device
  - Apple proposes a NAT64 solution to single protocol access networks
  - Applications are “encouraged” to ensure that they can operate in a IPv6 environment, potentially assisted by a back end NAT64 gateway

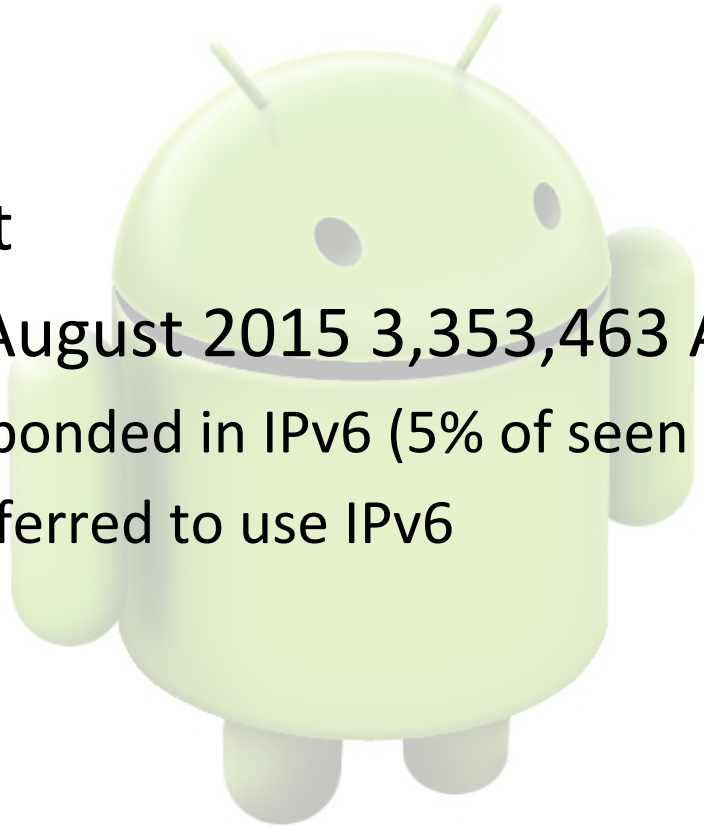
Mobile Devices and IPv6



Android

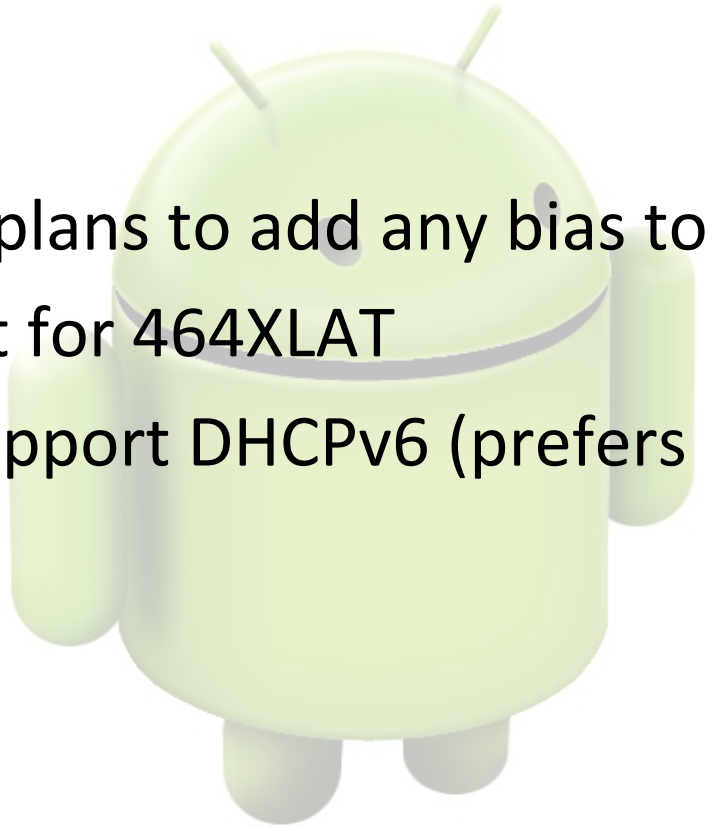
- No preference for IPv6 – uses a mechanism that should result in an approximate 50/50 split between IPv6 and IPv4 for dual stack
  - No public commitment to change this behaviour
- Browsers and other apps may add their own IPv6 selection bias

Mobile Devices and IPv6



- Android
  - Measurement
    - We saw in August 2015 3,353,463 Android devices
      - 175,922 responded in IPv6 (5% of seen android devices)
      - 151,754 preferred to use IPv6

Mobile Devices and IPv6



Android

- No current plans to add any bias to use IPv6
- Has support for 464XLAT
- Does not support DHCPv6 (prefers RA and PD framework)

It's not just Transitional Complexities…

Mobiles are multi-interface devices:

- Cellular radio
  - High unit cost, variable quality and speed, broad coverage
- WiFi
  - Low cost, better quality and speed, tethered-style coverage
- Bluetooth
  - Low cost, very limited radius
- USB (Ethernet)
  - Low cost, high quality and speed, physically tethered

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Can we take advantage of these multiple interfaces to improve speed and quality and also control costs?

It's not just Transitional Complexities…

Which leads multi-interface support and the matter of “Live Handoff”

Live Handoff

Can an live application switch between cellular radio and wireless services without dropping the call?

Live Handoff

Can an live applicat… between cellular … services without dropping the call?

Why is this an important question?

Live Handoff

- The traditional mobile providers operate with exclusive access to spectrum within defined locales (with associated license costs)
- Alternate access competitors can operate almost anywhere in unlicensed spectrum with WiFi network services
- Devices now include platform services that support connection agility across diverse access networks
- Customers see higher utility and (hopefully) lower costs for mobility services
- Cellular access operators see revenue erosion issues

Live Handoff

- The traditional mobile providers operate with exclusive access to spectrum within defined locales (with associated license costs)
- Alternat… …st
- …work
- …vices that support …gility across diverse access networks
- Customers see higher utility and (hopefully) lower costs for mobility services
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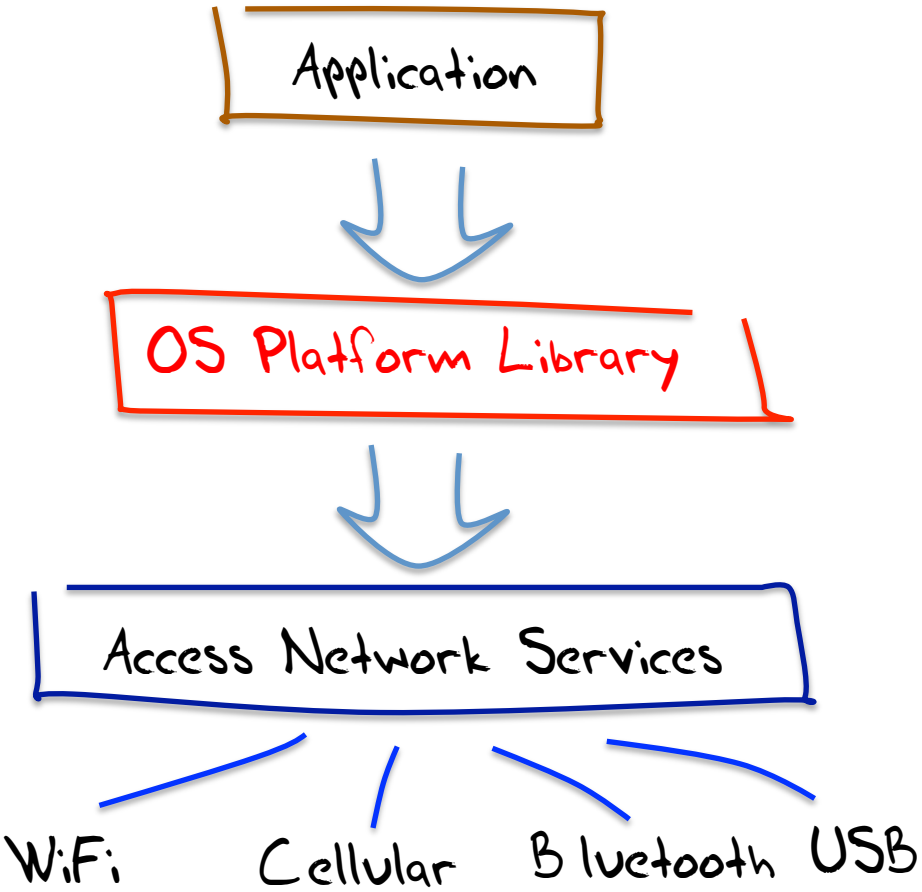
The billion dollar question is: Who gets to control this handoff between licensed and unregulated radio access services?

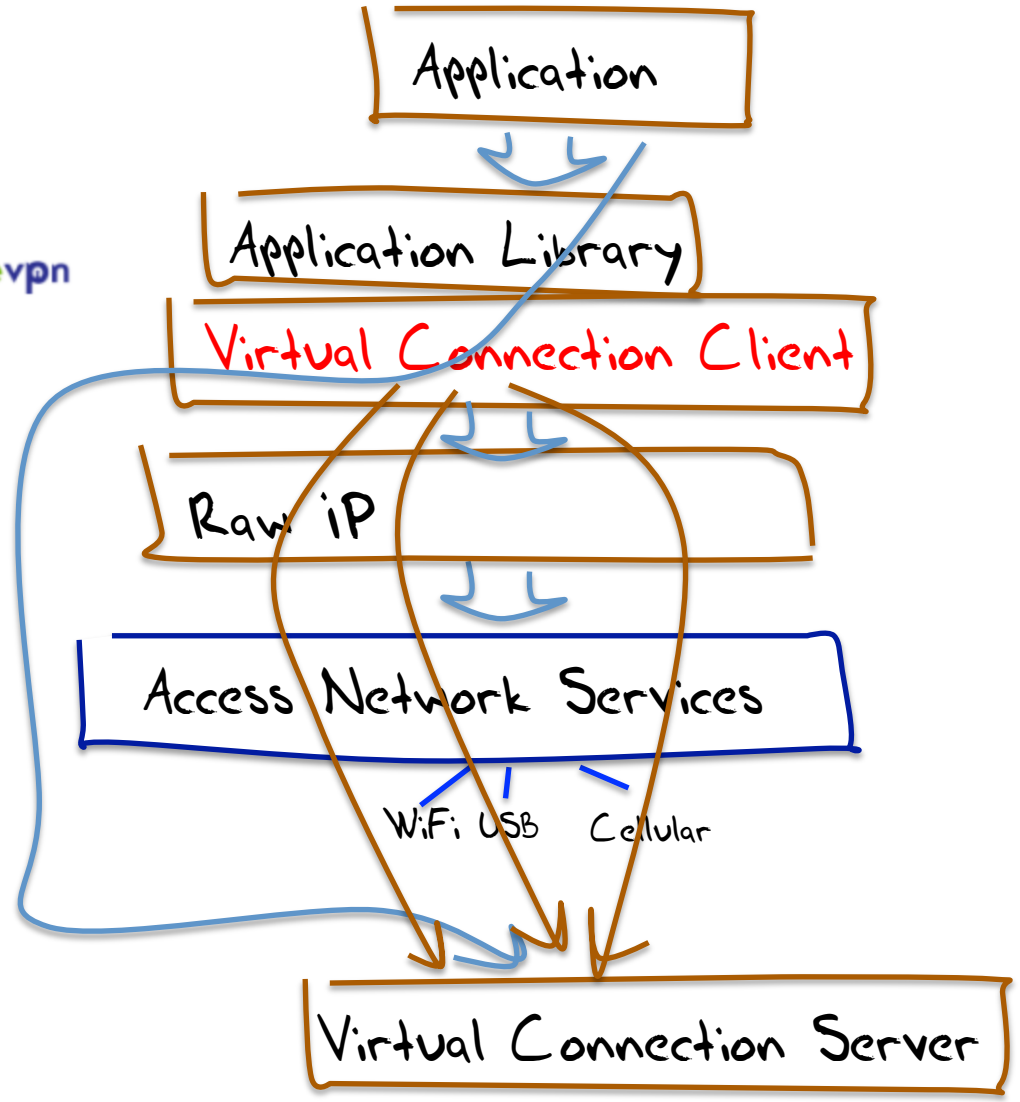
The "basic" Mobile Stack Model



The VPN approach

The VPN Application Approach:

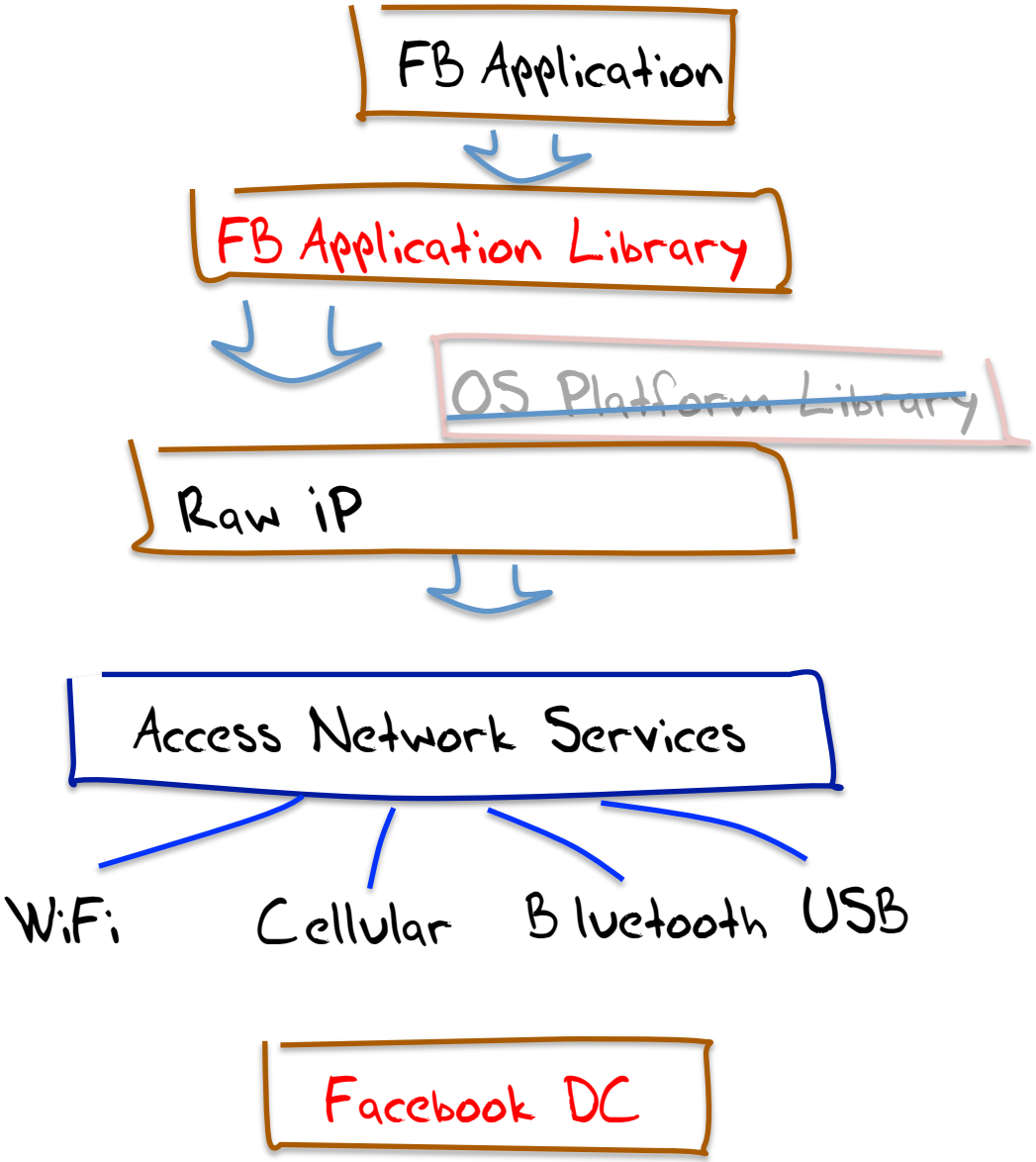
Hide the application traffic from both the local platform as well as the local network



The Application View

The Application Approach: Facebook

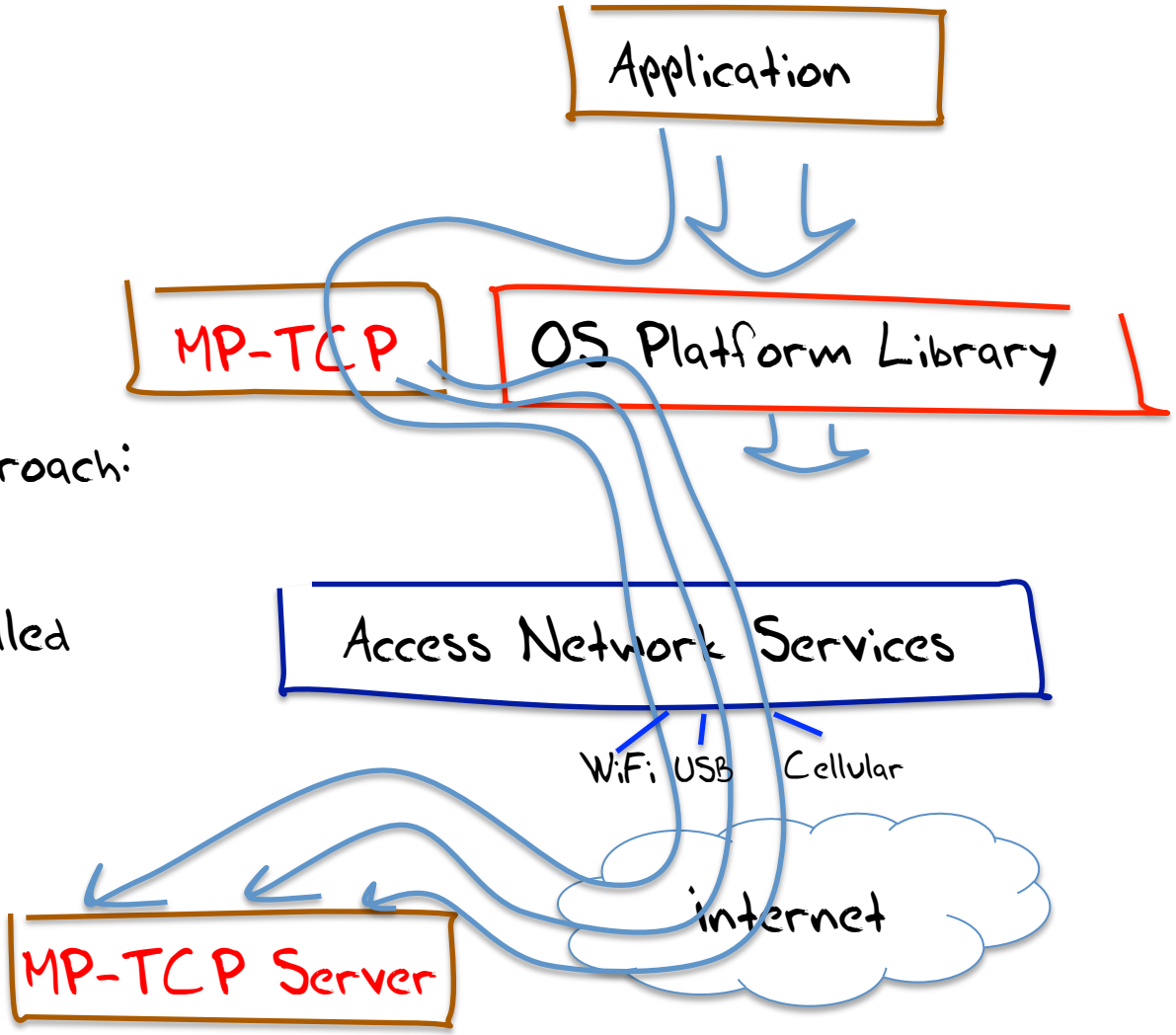
Fold the entire transport session control into the application



MP-TCP controller - Siri

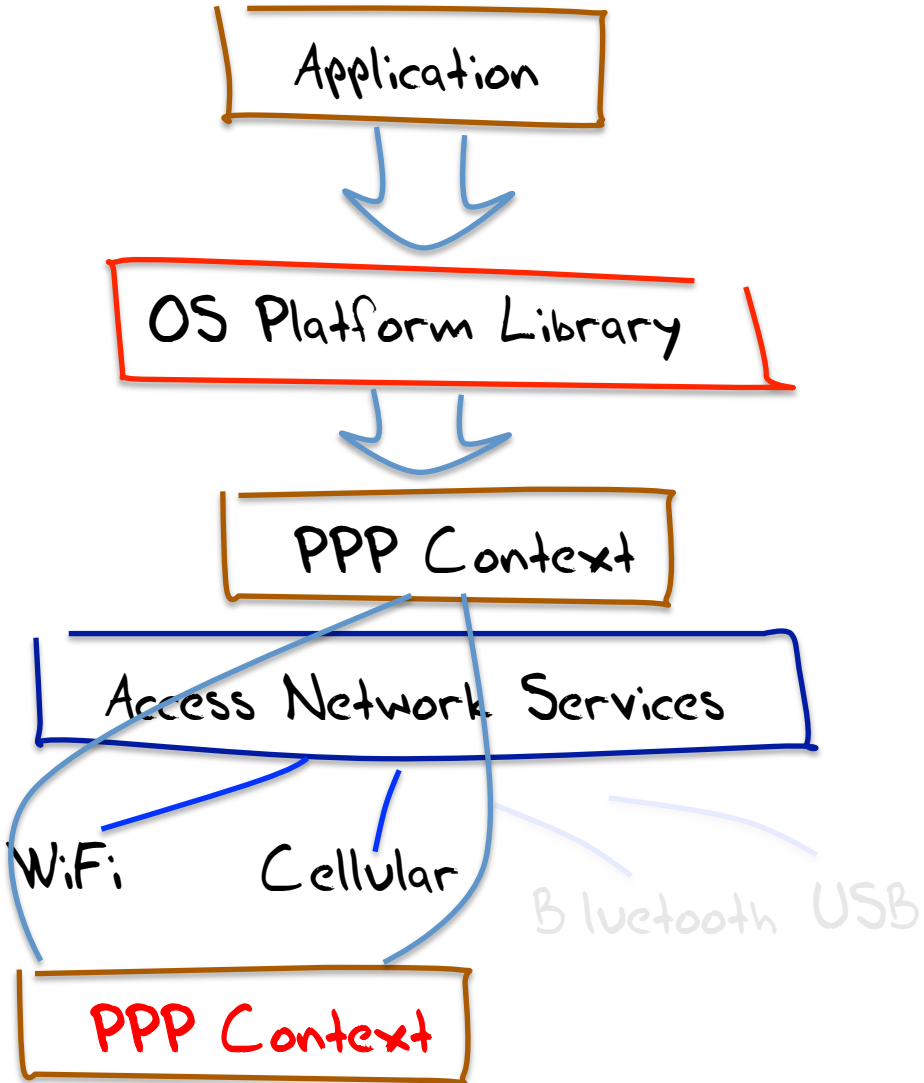
The MP-TCP Approach:
Apple's Siri

Application-Controlled
Handoff Agility



The cellular access operator's preferred response

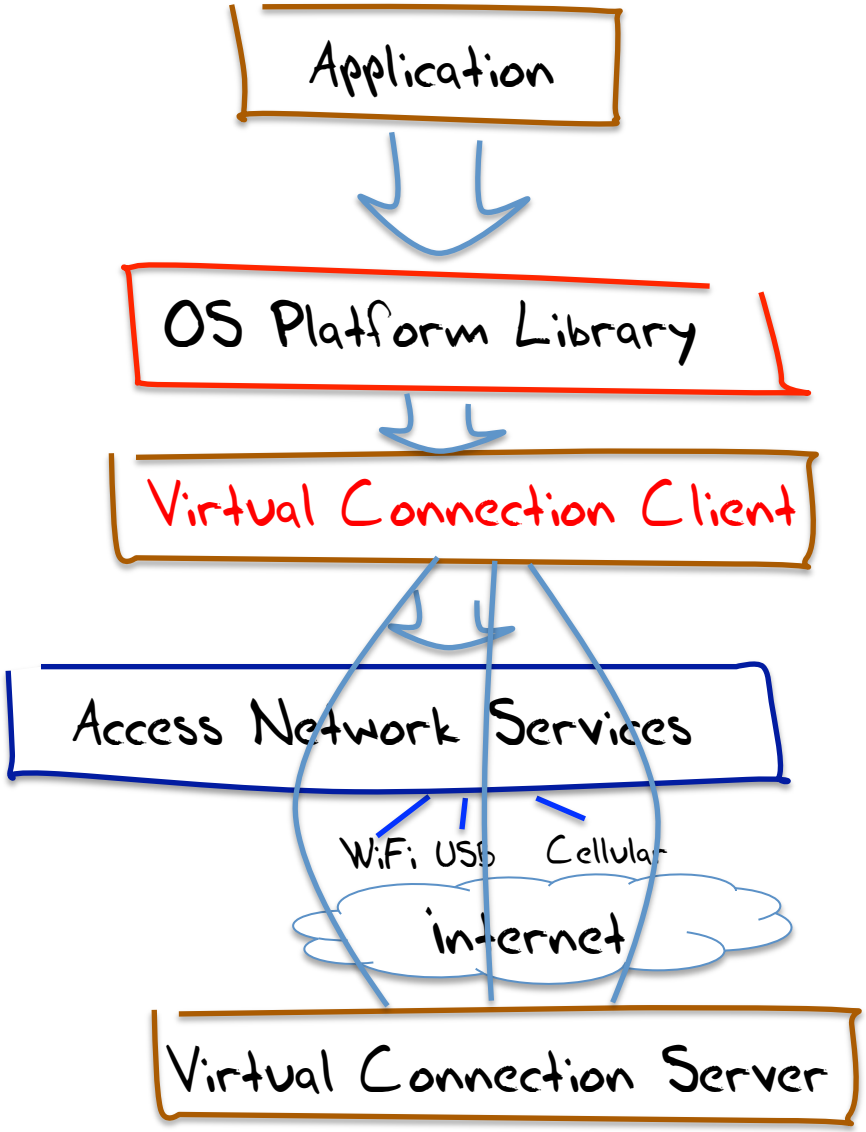
The handoff to WiFi is completely controlled by the cellular access network operator, and a PPP context between the device and the operator is maintained



Google in charge!

The Google Fi Approach:

OS-Controlled Seamless Handoff Agility



Mobility as a Simple Utility

Mobile Access Operators are being pushed into undistinguished utility roles

- No more voice premiums
- Erosive pressure on data service margins
- Pressure from WiFi service operators
- OS and App providers splitting away from carrier constraints
- Multi-Interface support turns mobile devices into opportunistic scavengers!

Mobility Paranoia

- Mobile Device manufacturers are being squeezed (except perhaps Apple!)
- Google and Apple now control the platform space
- Mutual trust issues are emerging between them
  - Such as Apple's Ad Blocker in iOS 9
- Apps are now turning on their own versions of paranoia!
  - In a market that is topping out in revenue terms each provider is attempting to protect itself by ring fencing its relationship with the end user

What we want

Consumers want more for less

- The love/hate relationship with ads and ad-funded services
- The rise of the content streamers
- (much) higher download speeds
- (much) larger data caps
- Lower premiums

Competitive pressure on providers to respond to this consumer pressure

What we can't get!

Exclusive Use radio spectrum is too expensive

- High access speeds require greater spectrum use per endpoint device
- Which can only be met with denser base station deployment (or lower access speeds)
- The increased spectrum demand and the lack of a price premium for high speed services implies lower revenue yield from the radio spectrum access license costs
- And there is no end in sight to this conundrum

Where now?

Has exclusive use radio spectrum outpriced itself in today's market?

- Consumers want WiFi performance for WiFi prices from the cellular radio network
- And that's a problem when you have to pay large sums for an exclusive use spectrum license!

Handing Off Mobiles

- With no ability to drop data prices without taking a hit on their bottom line cellular access providers have limited means to respond
  - Unless they can drop unit pricing and increase data caps then these cellular access providers pricing themselves out of the consumer market
  - Competitive WiFi access and application handover approaches are placing pressure on the traditional mobile operator's margins
- If the cellular providers want cheaper carriage then they need to look at augmenting their offering with WiFi base station handoff infrastructure and perform automated handoff from the cellular network to a WiFi access network

Who is Handing Off to Whom?

But the cellular operator has limited control over the handset's behaviour!

And the handset has limited control over the OS behaviour!

And the OS has limited control over the application's behaviour!

Where now for Mobiles?

The underlying observation here is that the mobile network operator has lost control of the mobile access device and the services offered across the mobile network

Where now for Mobiles?

And after losing that control there is no way back!

- The device OS platform vendors and the applications are charting a course that is in direct conflict with the mobile network operator's desires
- They are managing to monetize this far more efficiently than the mobile network operator
- Apple and Google are winning (for the moment!)

Where now for Mobiles?

Mobile operators are trying to confront competitive pressures with their own WiFi handoff approaches, while OS platforms and Apps are trying to place themselves in control and constrain the mobile providers into limited cellular data role

Where now for Mobiles?

Which means that there is increasing pressure to increase the shared unregulated spectrum allocation and increasing discontent with the behaviour of the exclusive spectrum holders

- Pressure for more regulated exclusive access spectrum allocations from the incumbent operators

- Pressure for more unregulated open access (WiFi) spectrum allocations from users and alternate providers

Public Policy pressure between direct license payments from incumbents and indirect economic efficiency outcomes from alternate use models

Where now for Mobiles?

Which means that there is increasing pressure to i… the shared unregulated spectrum alloca… with the behaviour of…

Mobility is here to stay – that's for sure!

– … locations

But the tensions between exclusive use and shared access spectrum models will continue for some time

– P… n al…

We are now exploring MiMO antenna technology and higher frequencies to push WiFi into Gbps

Public… cumbents and in… alternate use models

And the cellular folk are exploring 5G technologies which are also promising Gbps throughput

Looking Forward (dimly)

Mobility is just too handy

- Chips will get smaller
- Power drain will get smaller
- The single unit general purpose computer and packaged applications model is under pressure to change

Exactly how it will change is anyone's guess

- But it will change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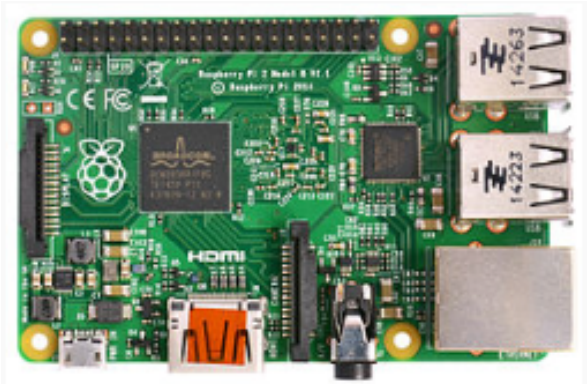
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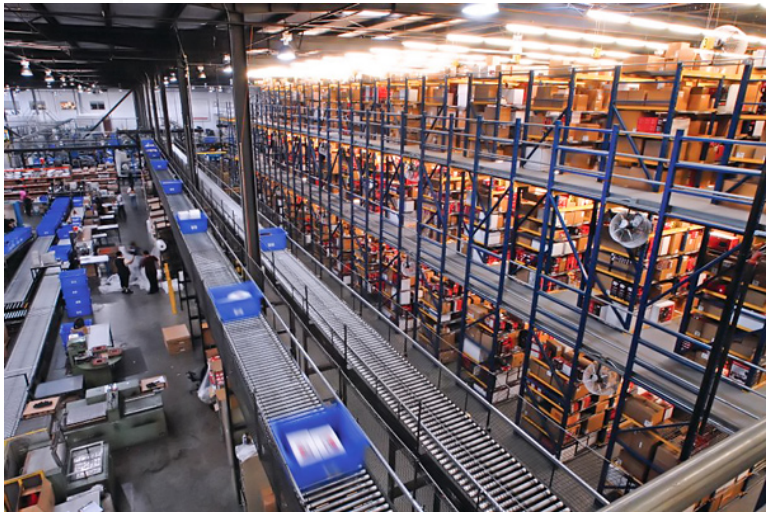

That's it!