

Lecture

Internet Trends and Web Basics

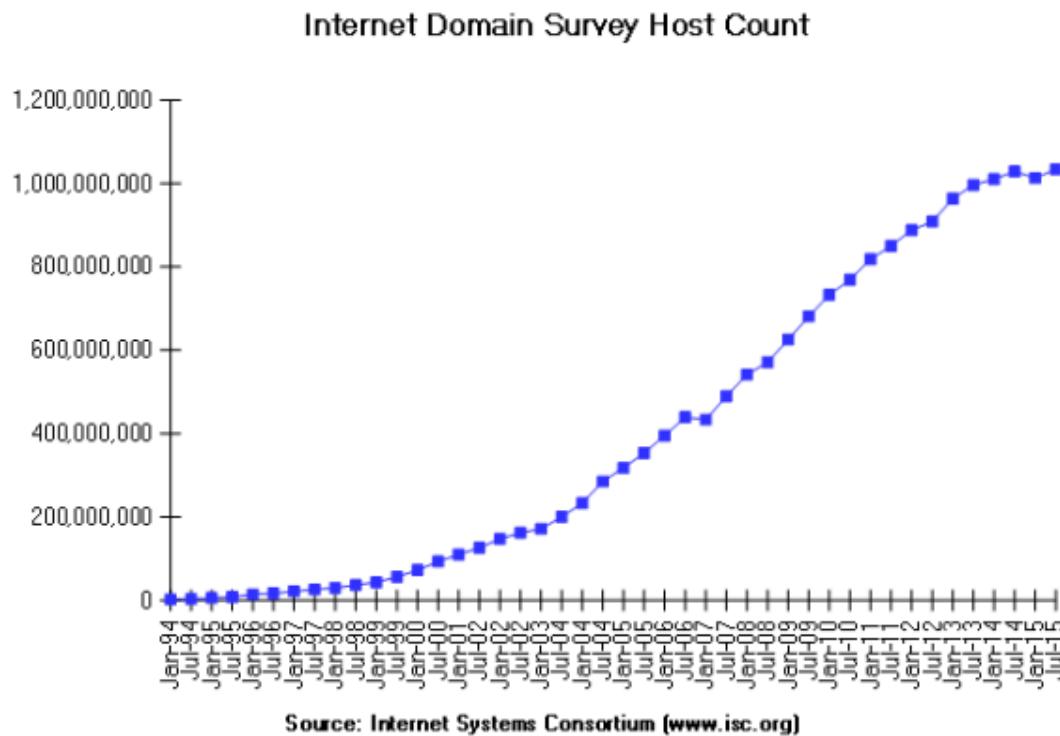
The Internet and the WWW are Different

- The *Internet* is a global digital infrastructure that connects hundreds of millions of computers and people
- The *World Wide Web* is a mechanism that unifies the retrieval and display of a subset of data on the Internet
- An *intranet* is a local/global information structure that connects an organization internally. Intranets today often make use of Web technologies
- An *extranet* is a private network that uses the public telecommunication system to securely share part of a business's information or operations with suppliers, vendors, partners, customers, or other businesses.

Recent Trends in Internet Development

- Growth in number of users connected
- Growth in Smartphone use, particularly iOS and Android
- Growth in digital data, especially photos and video
- Growth in Social Media
- Growth in Internet use from Mobile over desktop/laptop
- Growth in tablet usage over desktops/laptops
- Decreased dominance of Microsoft Windows

How Big is the Internet - <https://www.isc.org/network/survey>



hosts were doubling every 18 months, but growth has slowed
See the survey background at: <http://www.isc.org/network/survey>

It counts the number of IP addresses that have been assigned a name. The survey queries the domain name system for the name assigned to every possible IP address. But rather than sending a query to every one of the 4.3 billion possible IP addresses, the survey starts with a list of all network numbers that have been delegated within the IN-ADDR.ARPA domain.

Date	HostCount
Jul 15	1,033,836,245
Jan 15	1,012,706,608
Jul 14	1,028,544,414
Jan 14	1,010,251,829
Jul 13	996,230,757
Jan 13	963,518,598
Jul 12	908,585,739
Jan 12	888,239,420
Jul 11	849,869,781
Jan 11	818,374,269
Jul 10	768,913,036
Jan 10	732,740,444
Jul 09	681,064,561
Jan 09	625,226,456
Jul 08	570,937,778
Jan 08	541,677,360
Jul 07	489,774,269
Jan 07	433,193,199
Jul 06	439,286,364
Jan 06	394,991,609
Jul 05	353,284,187
Jan 05	317,646,084
Jul 04	285,139,107
Jan 04	233,101,481
Jan 03	171,638,297
Jul 02	162,128,493
Jan 02	147,344,723
Jul 01	125,888,197
Jan 01	109,574,429
Jul 00	93,047,785
Jan 00	72,398,092
Jul 99	56,218,000
Jan 99	43,230,000
Jul 98	36,739,000
Jan 98	29,670,000
Jul 97	19,540,000
Jan 97	16,146,000
Jul 96	12,881,000
Jan 96	9,472,000
Jul 95	6,642,000
Jan 95	4,852,000
Jul 94	3,212,000
Jan 94	2,217,000
Jul 93	1,776,000
Jan 93	1,313,000

Countries with Internet Penetration >45%, 2014

As of 2014 there are 2.8 billion Internet users, with yearly growth at 8%; China and the USA have the largest number of Internet users and the penetration of the population in China remains small

Rank	Country	2014 Internet Users (MM)	2014 Internet User Growth	2013 Internet User Growth	Population Penetration	Total Population (MM)	Per Capita GDP (\$000)
1	China	632	7%	10%	47%	1,356	\$13
2	United States	269	2	2	84	319	\$55
3	Japan	110	0	9	86	127	\$37
4	Brazil	105	4	12	52	203	\$16
5	Russia	87	15	9	61	142	\$25
6	Germany	68	0	1	84	81	\$46
7	United Kingdom	57	4	1	90	64	\$40
8	France	54	-1	5	82	66	\$40
9	Iran (I.R.)	49	8	16	60	81	\$17
10	Egypt	43	15	13	50	87	\$11
11	Korea (Rep.)	42	1	1	85	49	\$35
12	Turkey	38	4	6	46	82	\$20
13	Italy	36	1	2	58	62	\$35
14	Spain	34	0	7	72	48	\$34
15	Canada	30	0	5	86	35	\$45
Top 15		1,653	5%	7%	59%	2,800	
World		2,793	8%	10%	39%	7,176	



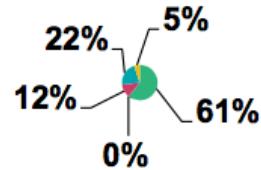
Source: United Nations / International Telecommunications Union, US Census Bureau. Internet user data is as of mid-year. Internet user data for: China from CNNIC, India from IAMAI, Iran from Islamic Republic News Agency, citing data released by the National Internet Development Center, Indonesia from APJII / eMarketer.

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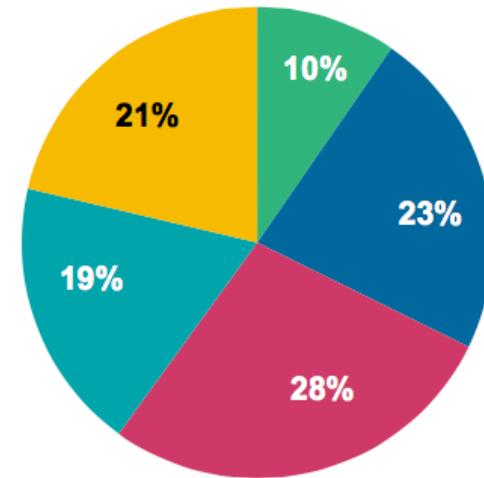
The following 17 slides are based upon a presentation by Mary Meeker of Kleiner Perkins Caufield and Byers, see <http://www.kpcb.com/insights/2014-internet-trends> and <http://www.kpcb.com/insights/2015-internet-trends>

Internet Users – 1995 → 2014... <1% to 39% Population Penetration Globally

1995
35MM+ Internet Users
0.6% Population Penetration



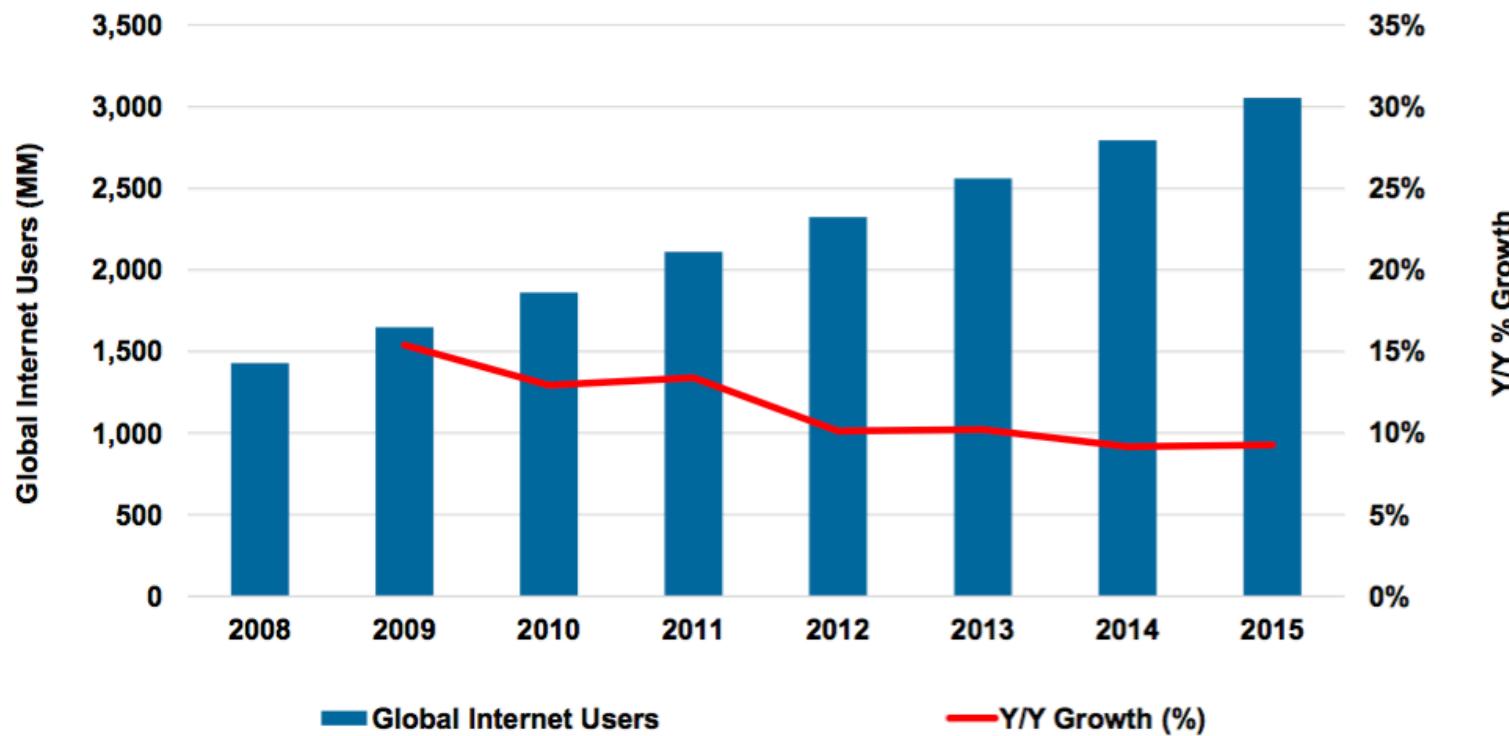
2014
2.8B Internet Users
39% Population Penetration



■ USA ■ China ■ Asia (ex. China) ■ Europe ■ Rest of World

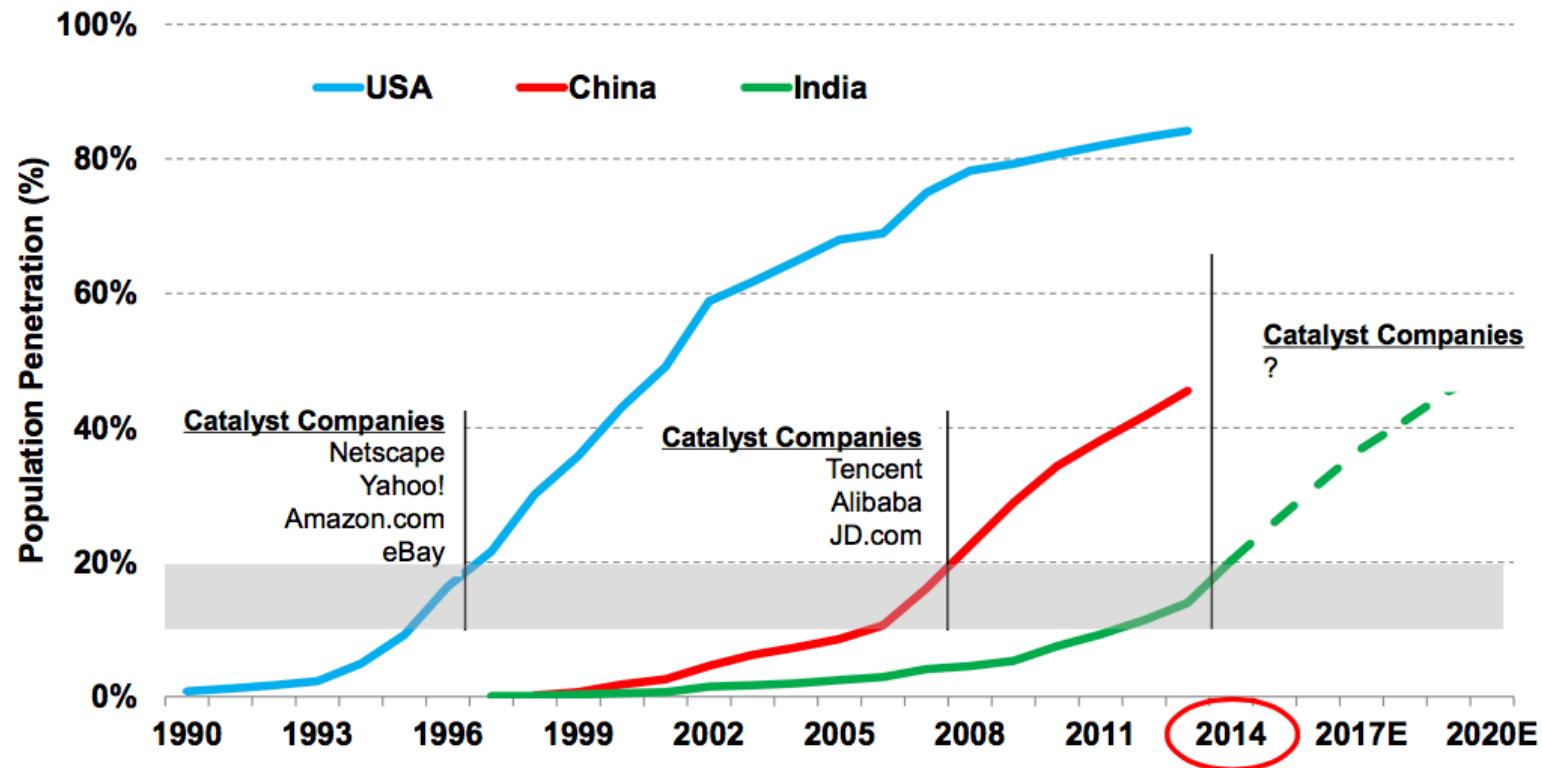
Global Internet Users = 3B @ 42% Penetration...
+9% vs. +9% Y/Y...+7% (Excluding India)

Global Internet Users, 2008 – 2015



India = Appears to Be @ Internet Penetration Growth Inflection

Internet User Penetration Curve, USA / China / India, 1990 – 2020E



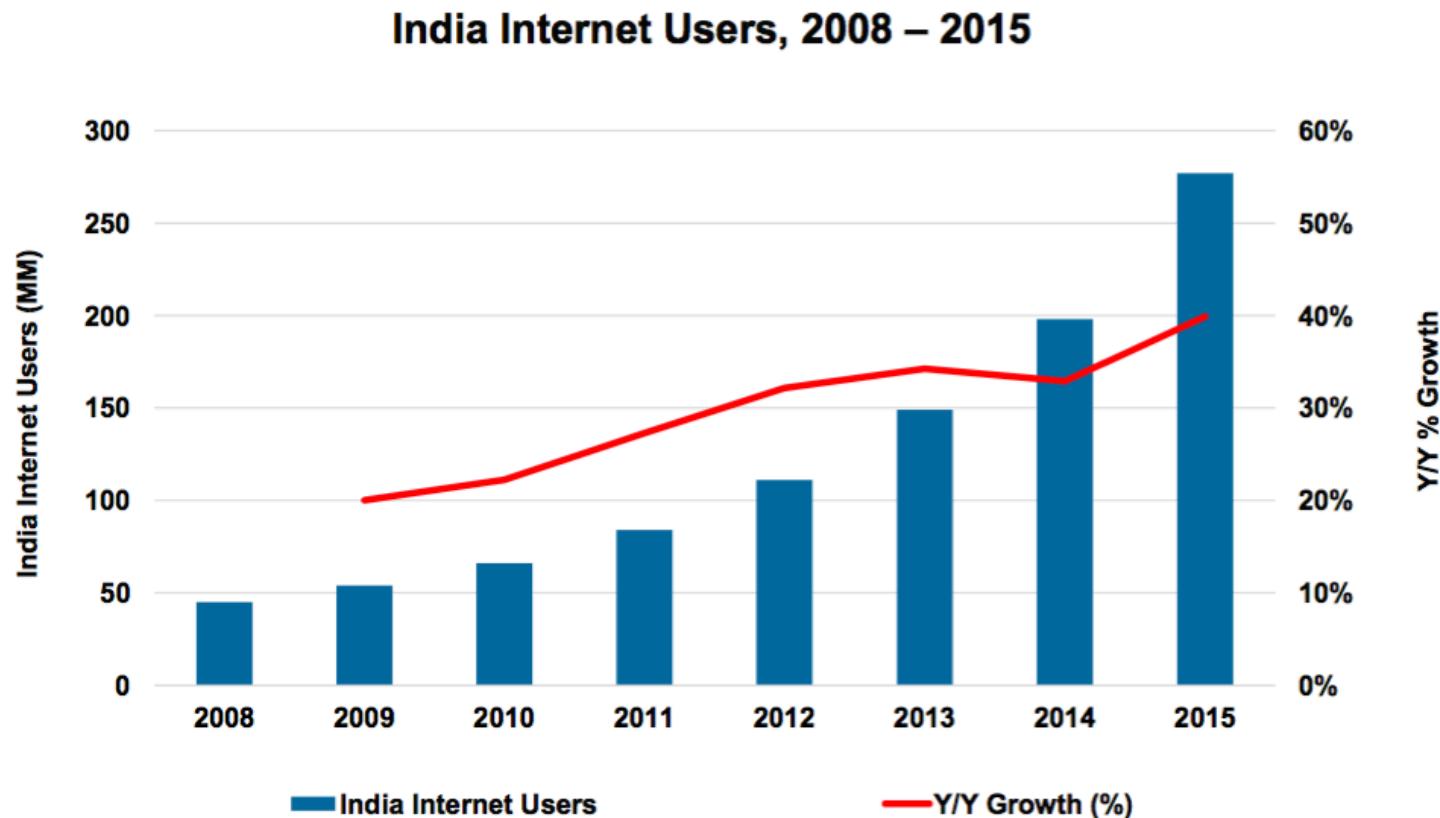
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Source: World Bank, Hillhouse Capital forecast for India beyond 2014.

Hillhouse Capital

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India Internet Users = 277MM @ 22% Penetration...
+40% vs. +33% Y/Y



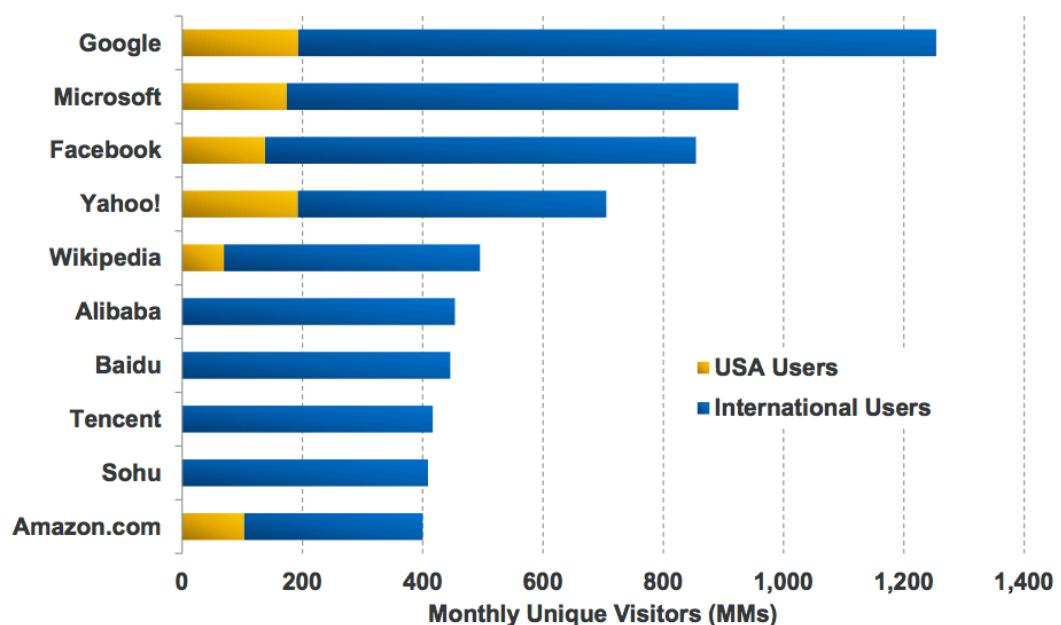
The US leads in the development of highly popular Internet websites;

Baidu is a Chinese search engine

*Tencent is a Chinese holding company of Internet properties, among the most popular being, QQ, for chatting;
Sohu.com Inc. is a Chinese online media, search, gaming, community and mobile service group.*

3/14 – 6 of Top 10 Global Internet Properties ‘Made in USA’... >86% of Their Users Outside America...China Rising Fast

Top 10 Internet Properties by Global Monthly Unique Visitors, 3/14

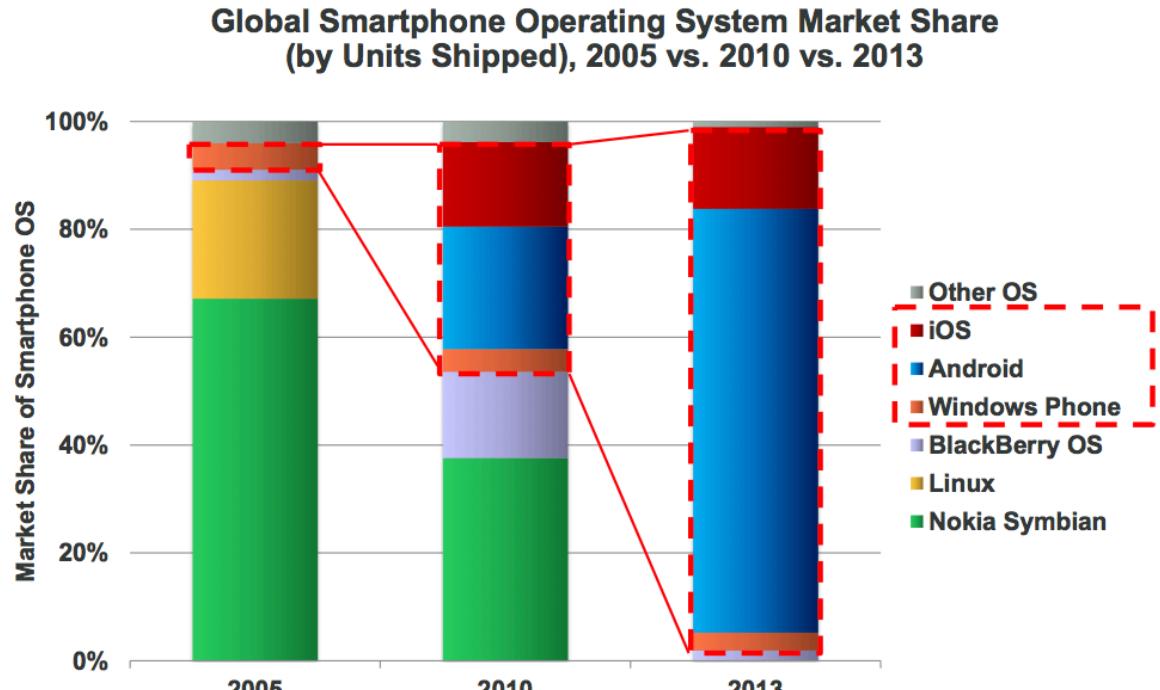


@KPCB Source: comScore, 3/14.

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Global Smartphone Operating Systems 'Made in USA'... 97% Share from 5% Eight Years Ago

Examining smartphone operating systems, over the past seven years, iOS and Android have made major gains with Nokia slipping greatly and Linux a very small piece of the pie



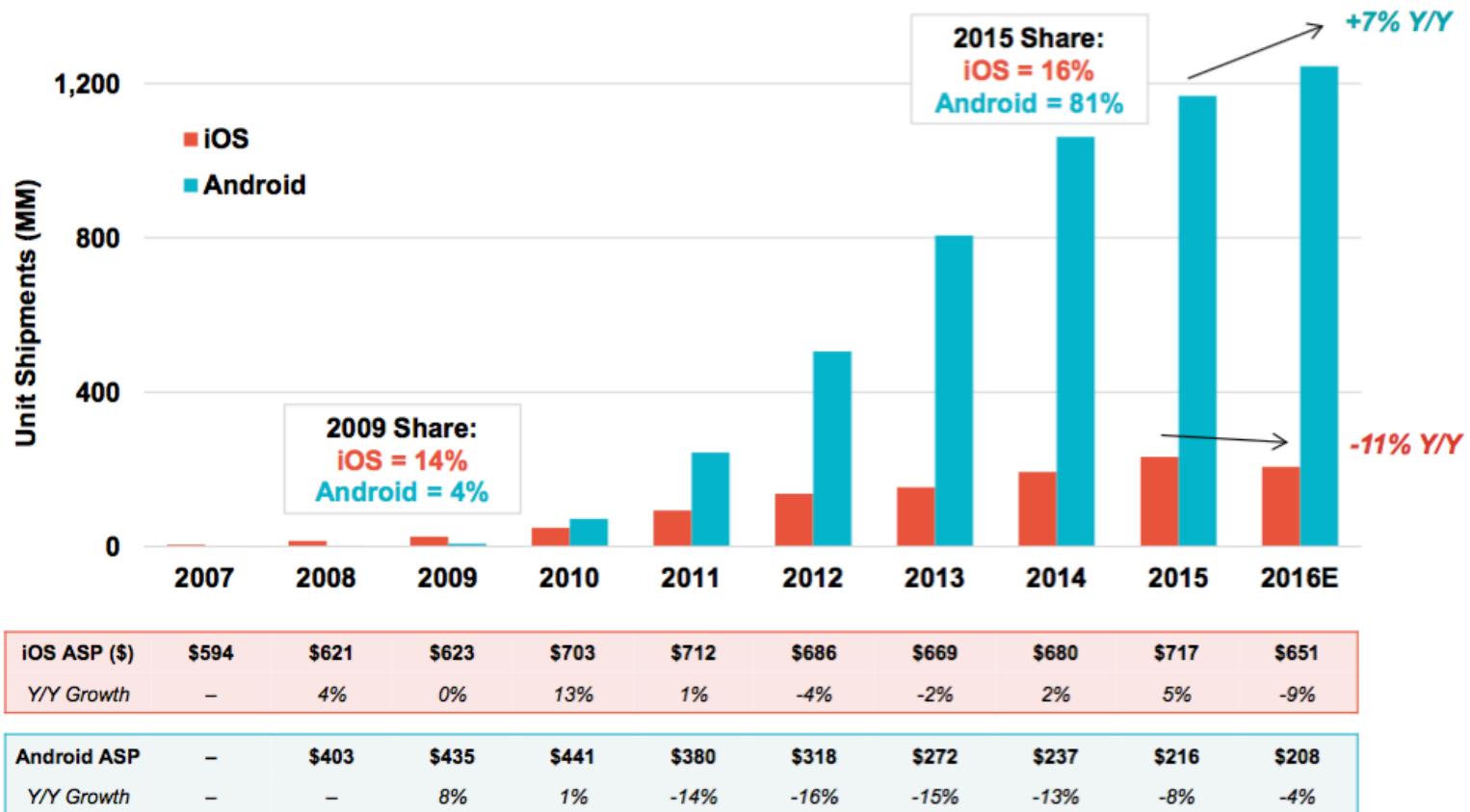
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Source: 2005 & 2010 data per Gartner, 2013 data per IDC.

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Android Smartphone Share Gains Continue vs. iOS... Android ASP Declines Continue...Delta to iOS @ ~3x

Smartphone Unit Shipments, iOS vs. Android, Global, 2007 – 2016E



World's Content is Increasingly Findable + Shared + Tagged - Digital Info Created + Shared up 9x in Five Years

There has been exponential growth
in online information;

1 Zettabyte = 1,024 Exabytes

1 Exabyte = 1,024 Petabytes

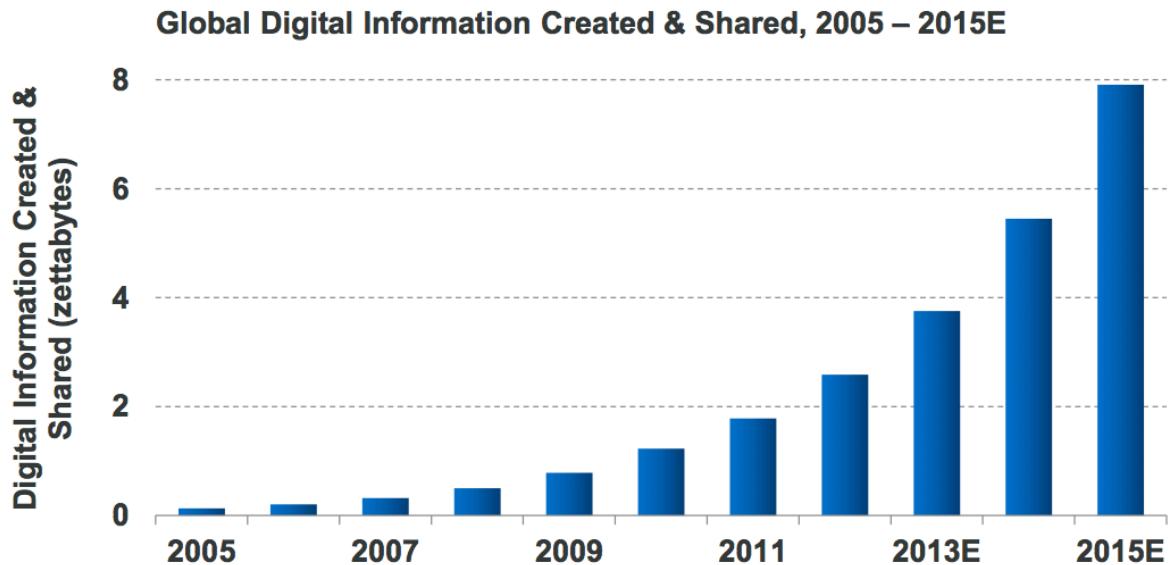
1 Petabyte = 1,024 Terabytes

1 Terabyte = 1,024 Gigabytes

or

1 Zettabyte = 1,000,000,000,000
gigabytes

*Amount of global digital information created & shared
– from documents to pictures to tweets –
grew 9x in five years to nearly 2 zettabytes* in 2011, per IDC.*



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Note: * 1 zettabyte = 1 trillion gigabytes. Source: IDC report "Extracting Value from Chaos" 6/11. 11

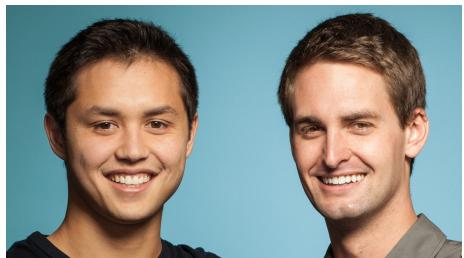
Photos Alone = 1.8B+ Uploaded & Shared Per Day... Growth Remains Robust as New Real-Time Platforms Emerge

500 million photos are uploaded every day and that number is doubling every year

Yahoo has recently made a major upgrade to **Flickr**

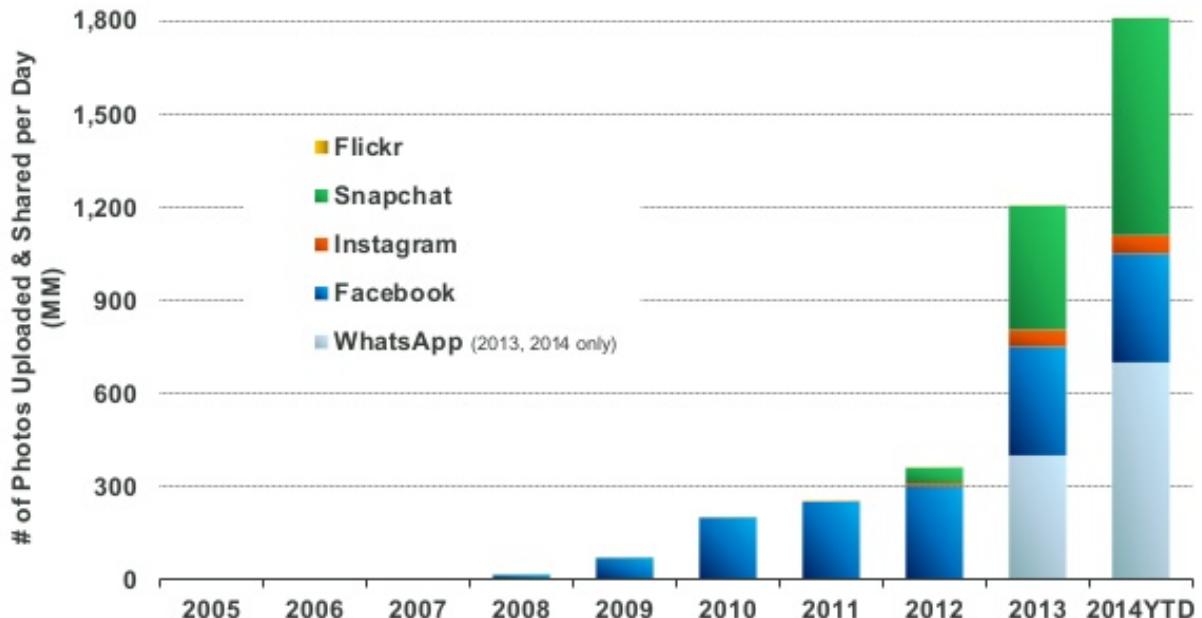
Instagram was recently (2010) purchased by Facebook for \$1 billion

Snapchat is a photo messaging application developed by two Stanford students (\$9B valuation);



bobby Murphy - Evan Spiegel

Daily Number of Photos Uploaded & Shared on Select Platforms,
2005 – 2014YTD

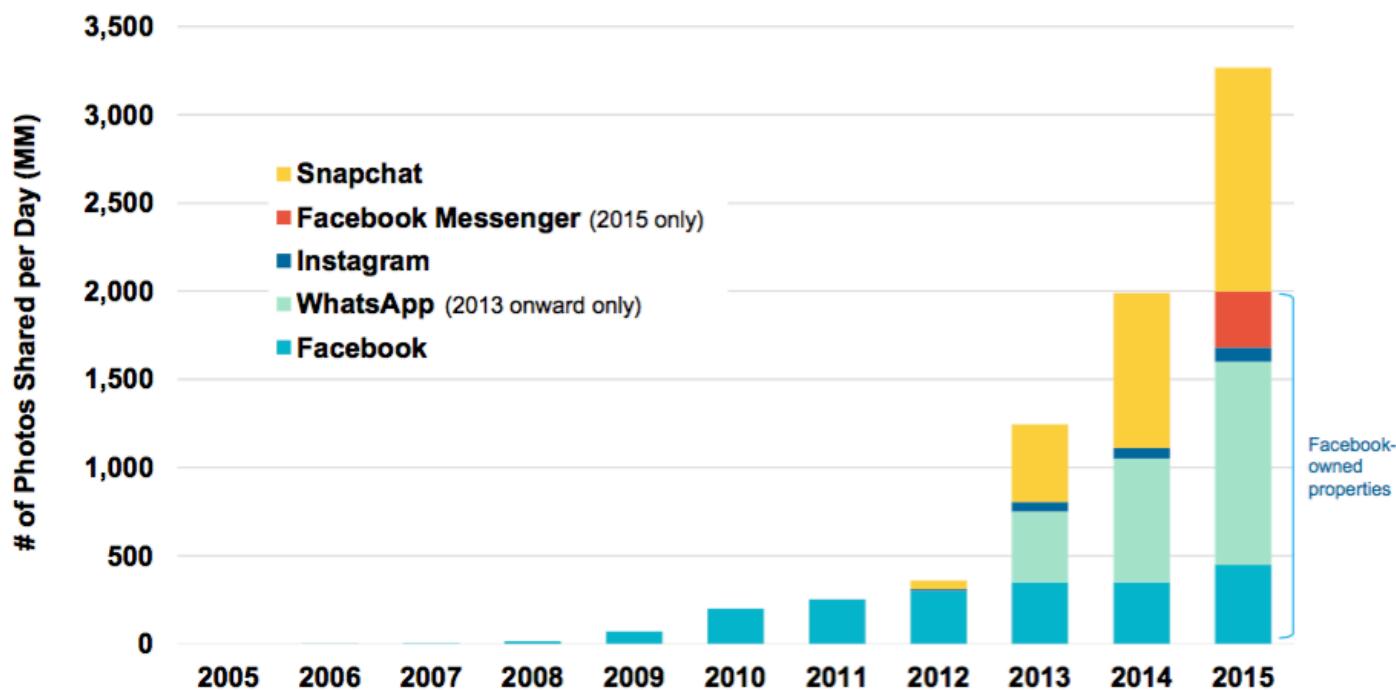


Source: KPCB estimates based on publicly disclosed company data, 2014 YTD data per latest as of 5/14.

Photo credit: KPCB

Image Growth Remains Strong

Daily Number of Photos Shared on Select Platforms, Global, 2005 – 2015



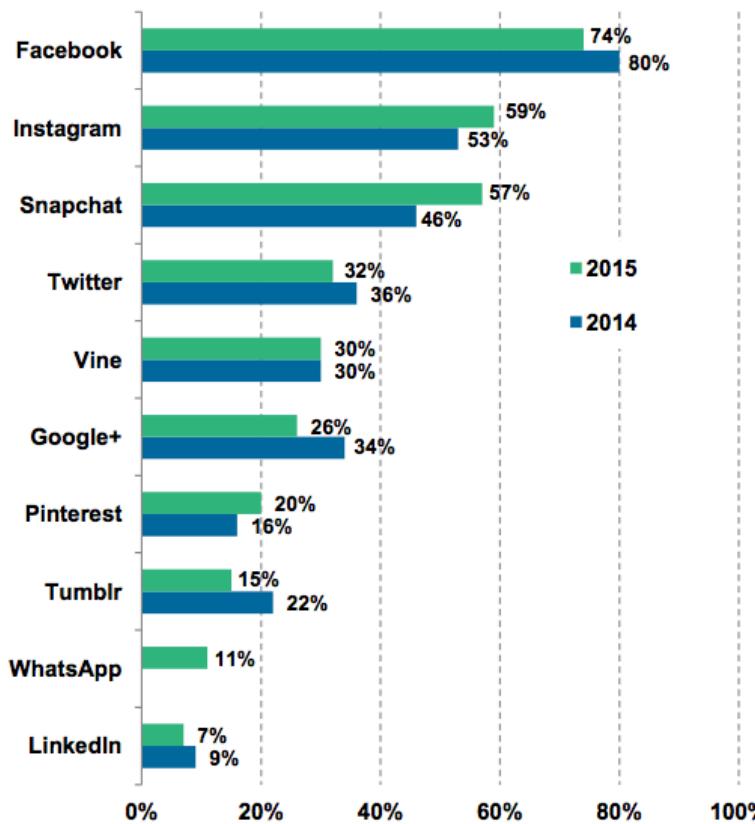
Source: Snapchat, Company disclosed information, KPCB estimates.
Note: Snapchat data includes images and video. Snapchat stories are a compilation of images and video. WhatsApp data estimated based on average of photos shared disclosed in Q1:15 and Q1:16. Instagram data per Instagram press release. Messenger data per Facebook (~9.5B photos per month). Facebook shares ~2B photos per day across Facebook, Instagram, Messenger, and WhatsApp (2015).

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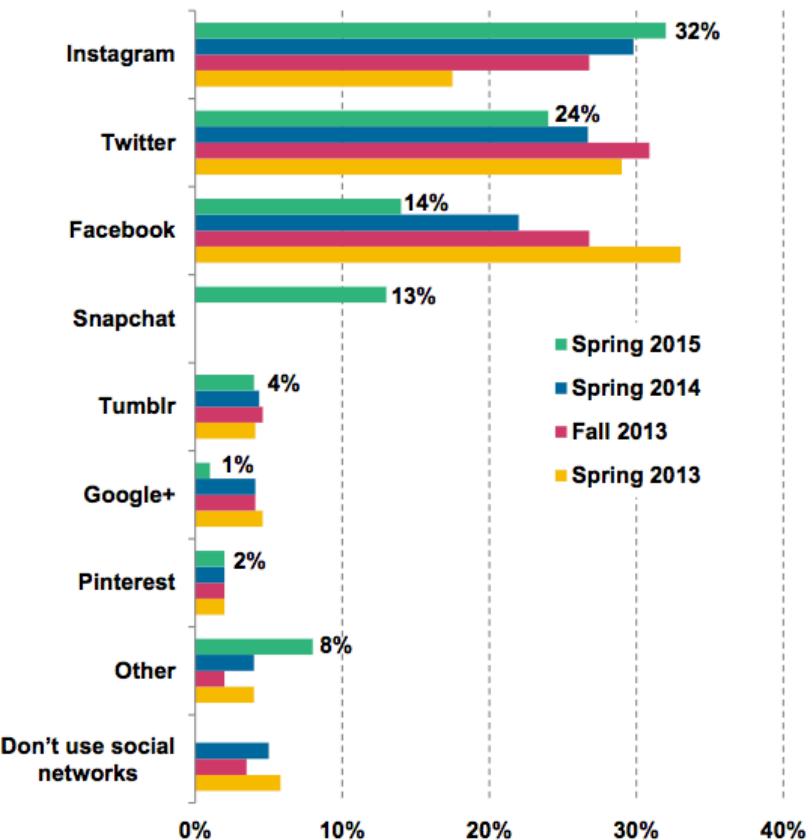
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12-24 Year Olds Internet Usage = Visual Stuff (In & Out) Rules... Instagram + Snapchat + Pinterest = Continue to Rise

**Social Media Usage Among American Youth
(Age 12-24)¹, USA, 3/15**



Teens' Most Important Social Network², USA, 4/15



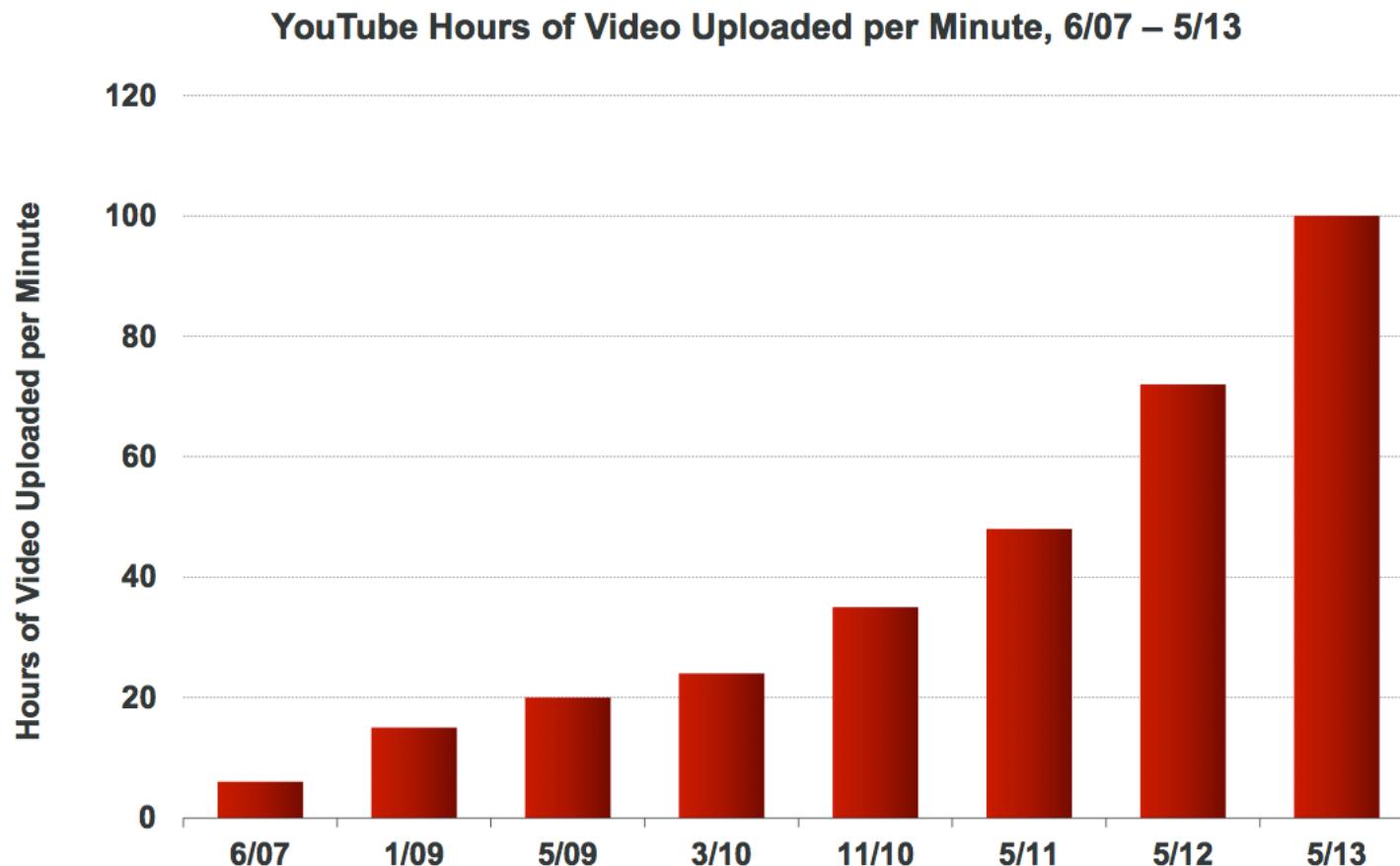
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Source: Edison Research / Triton Digital, Piper Jaffray.

Note: (1) 12-24 year olds who currently ever use social networking sites/services. (2) Based on survey of US teens with an average age of 16.3 years.

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Video = 100 Hours Per Minute Uploaded to YouTube, Up from ~Nada Six Years Ago



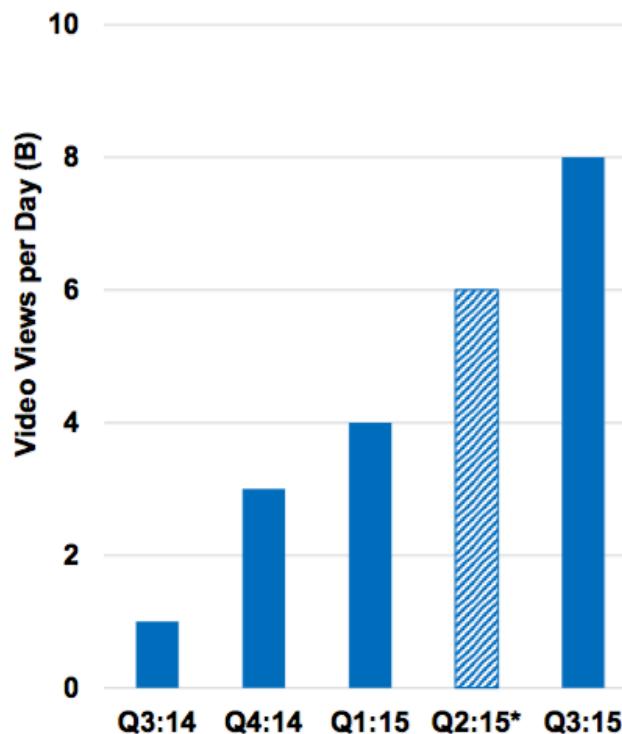
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Source: YouTube.

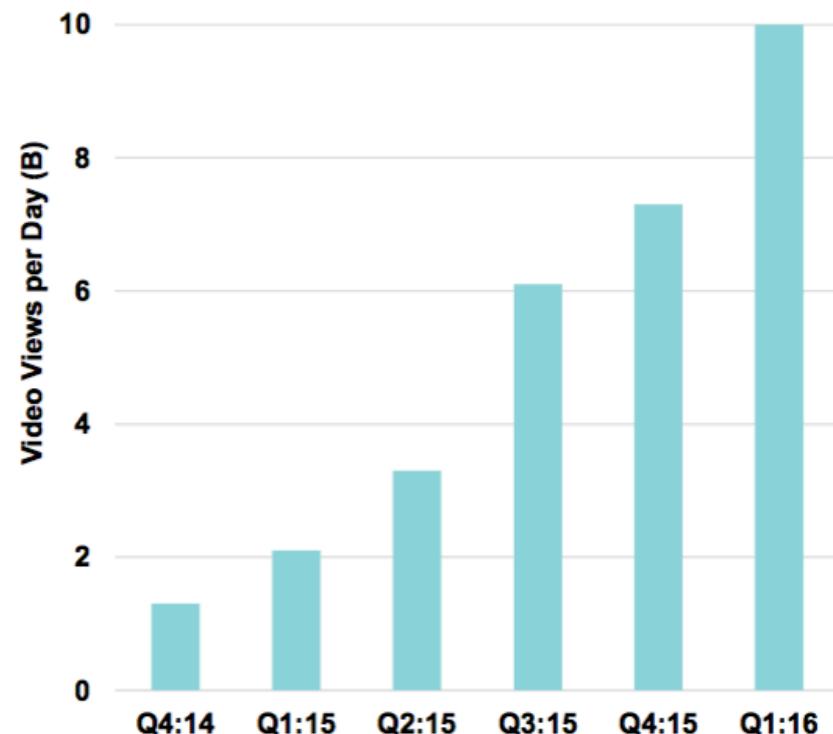
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User-Shared Video Views on Snapchat & Facebook = Growing Fast

**Facebook Daily Video Views,
Global, Q3:14 – Q3:15**



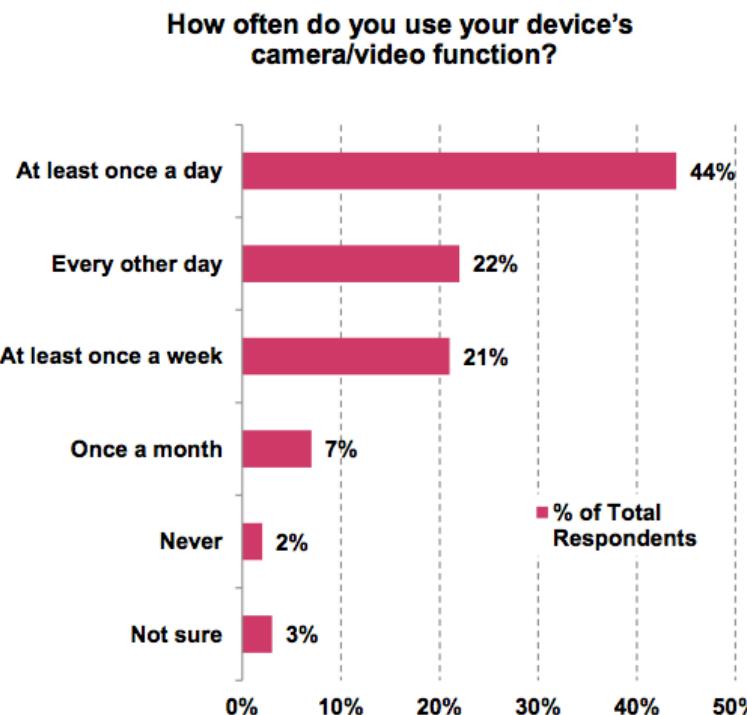
**Snapchat Daily Video Views,
Global, Q4:14 – Q1:16**



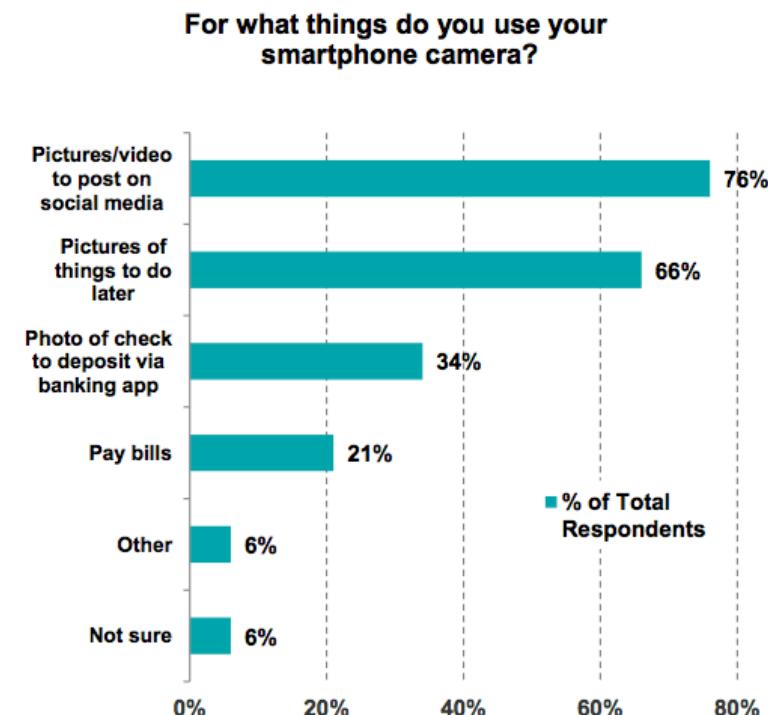
Millennials Love Their Smartphone Cameras...

44% Use Camera / Video Function Daily...76% Post on Social Media

**Millennial Smartphone Camera Usage*,
USA, 2014**



**Millennial Smartphone Camera Use Cases,
USA, 2014**



Source: Zogby Analytics.

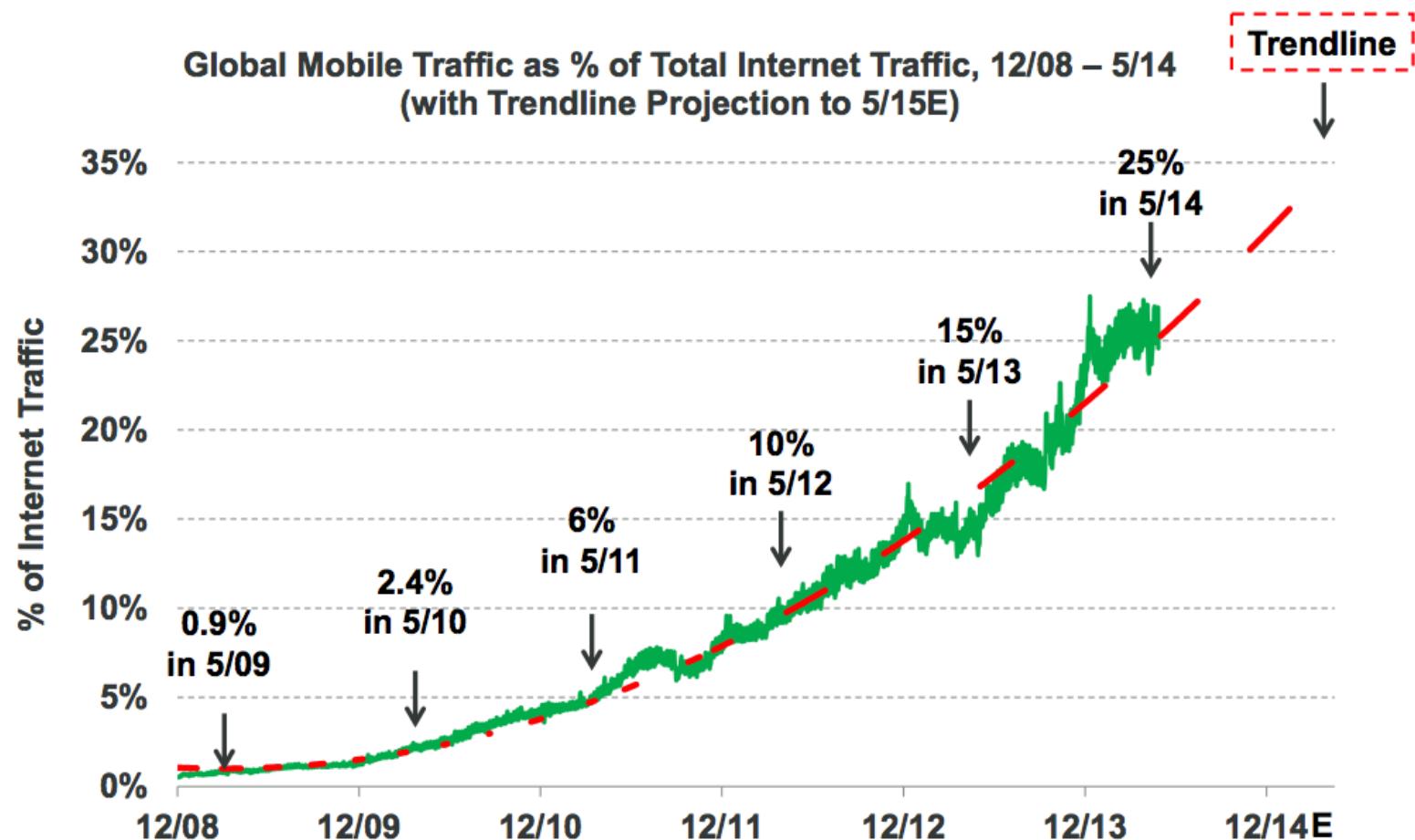
*18-24 year olds.

Note: Zogby Analytics was commissioned by Mitek Systems, Inc. to conduct an online survey of 1,019 millennials who have a smartphone. For the purposes of this survey, "millennials" are defined as adults between the ages of 18-34. All interviews were completed May 30 through June 6, 2014.



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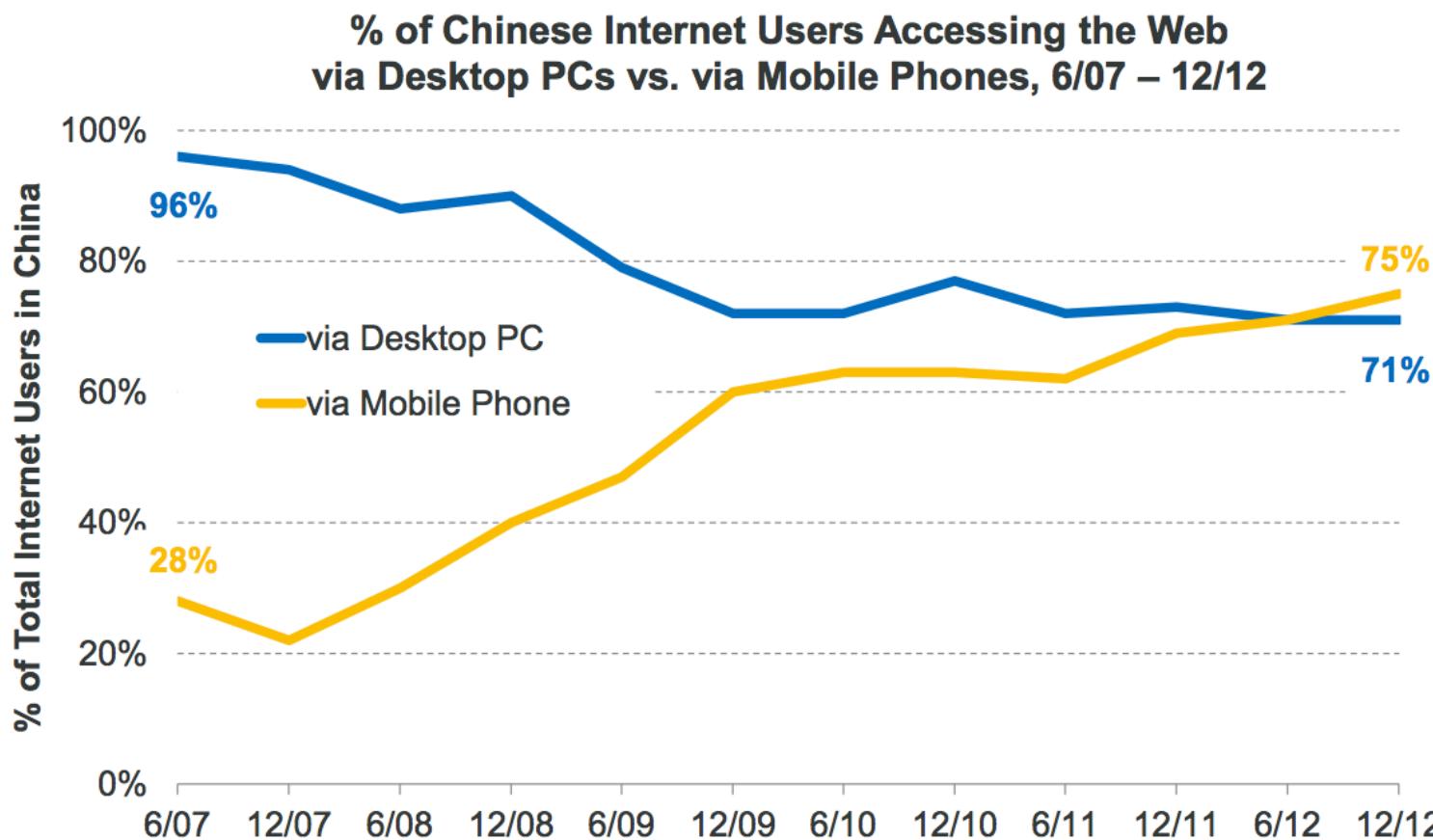
Mobile Traffic as % of Global Internet Traffic =
Growing >1.5x per Year & Likely to Maintain Trajectory or Accelerate



Source: StatCounter Global Stats, 5/14. Note that PC-based Internet data bolstered by streaming.

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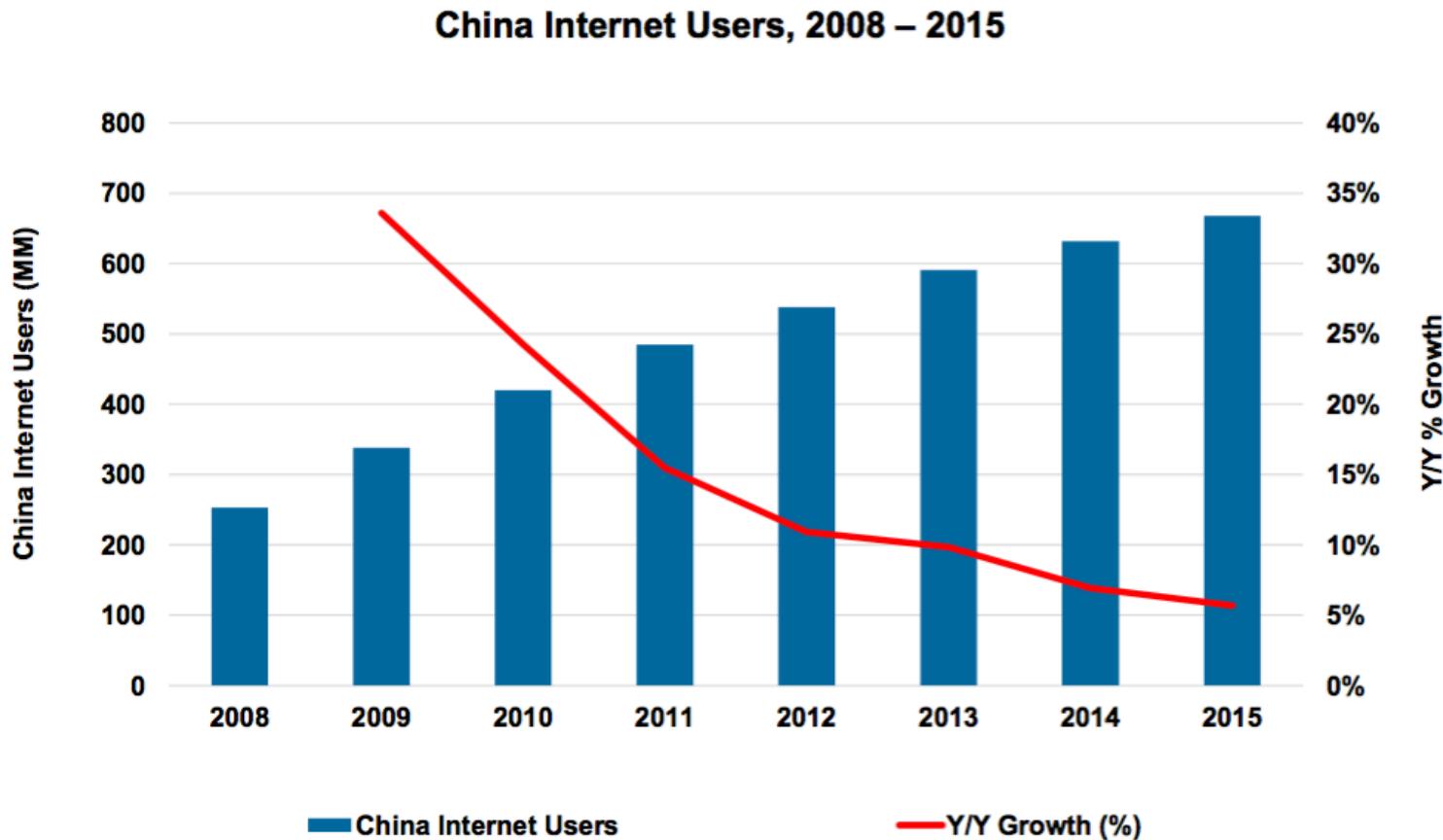
China – Mobile Internet Access Surpassed PC, Q2:12



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Source: CNNIC, 1/13. 33

China Internet Users = 668MM, +6% vs. 7% Y/Y...@ 49% Penetration

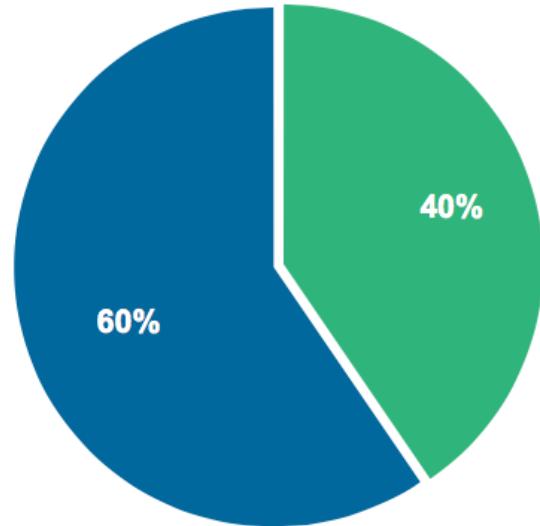


Mobile Phone Users – 1995 → 2014... 1% to 73% Population Penetration Globally

1995
80MM+ Mobile Phone Users
1% Population Penetration



2014
5.2B Mobile Phone Users
73% Population Penetration



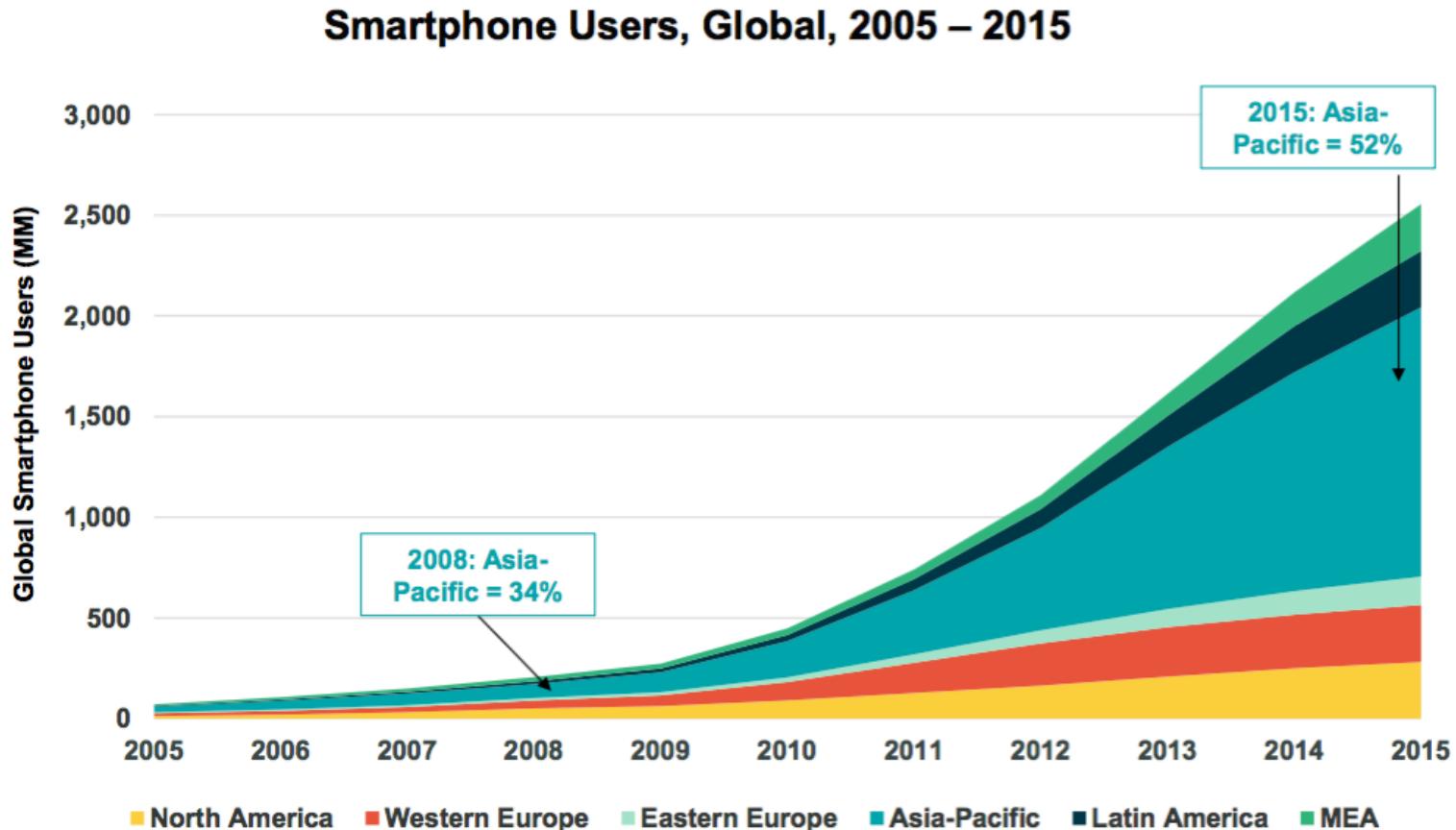
■ Smartphone ■ Feature Phone



Source: Informa, World Cellular Information Service (WCIS). Assumes in 1995, one mobile phone subscription per unique user (no duplication).
Note: In 2014, user base per KPCB estimates based on Morgan Stanley Research and ITU data. Smartphone users & mobile phone users represent unique individuals owning mobile devices; mobile subscribers based on number of connections & may therefore overstate number of mobile users.

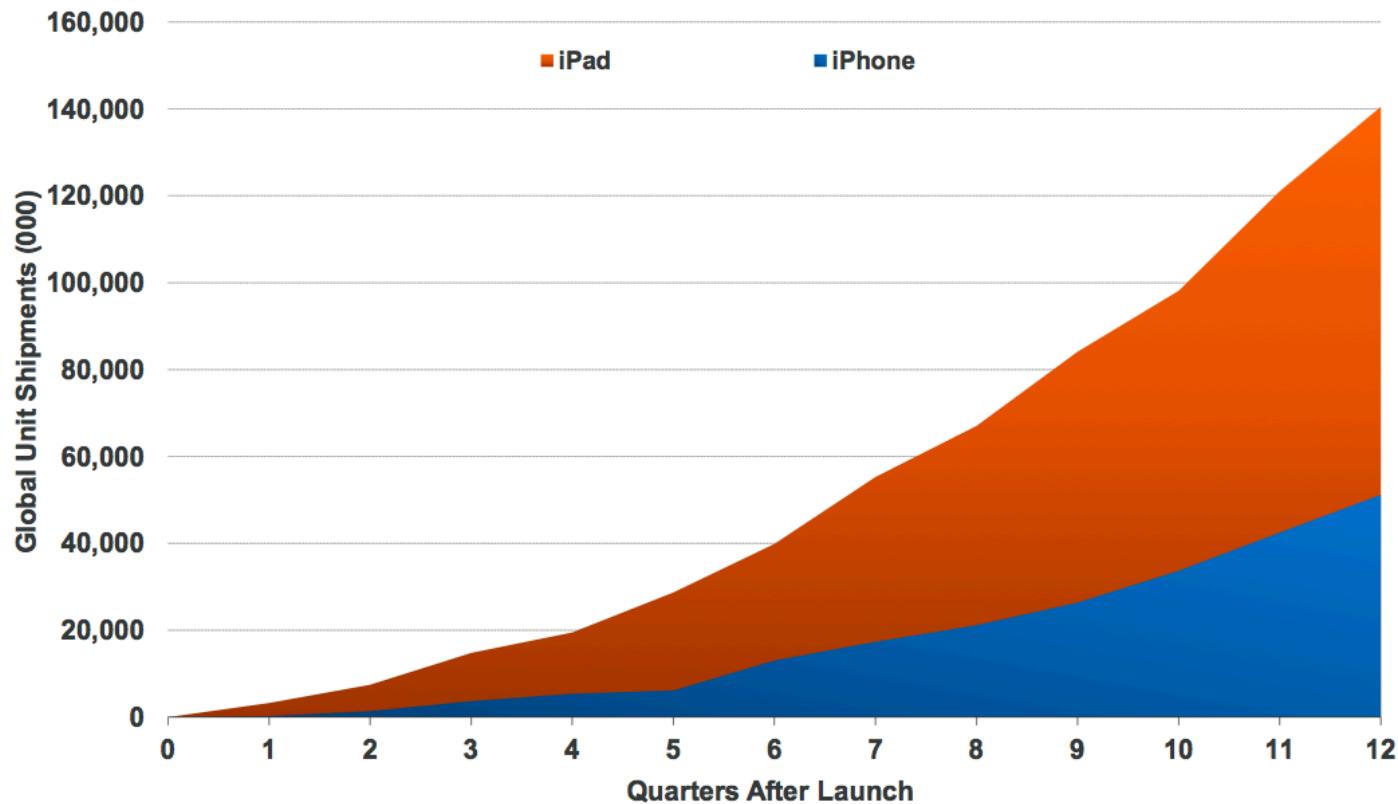
5

Global Smartphone User Growth Slowing... Largest Market (Asia-Pacific) = +23% vs. +35% Y/Y



Tablet Growth = More Rapid than Smartphones, iPad = ~3x iPhone Growth

First 12 Quarters Cumulative Unit Shipments, iPhone vs. iPad

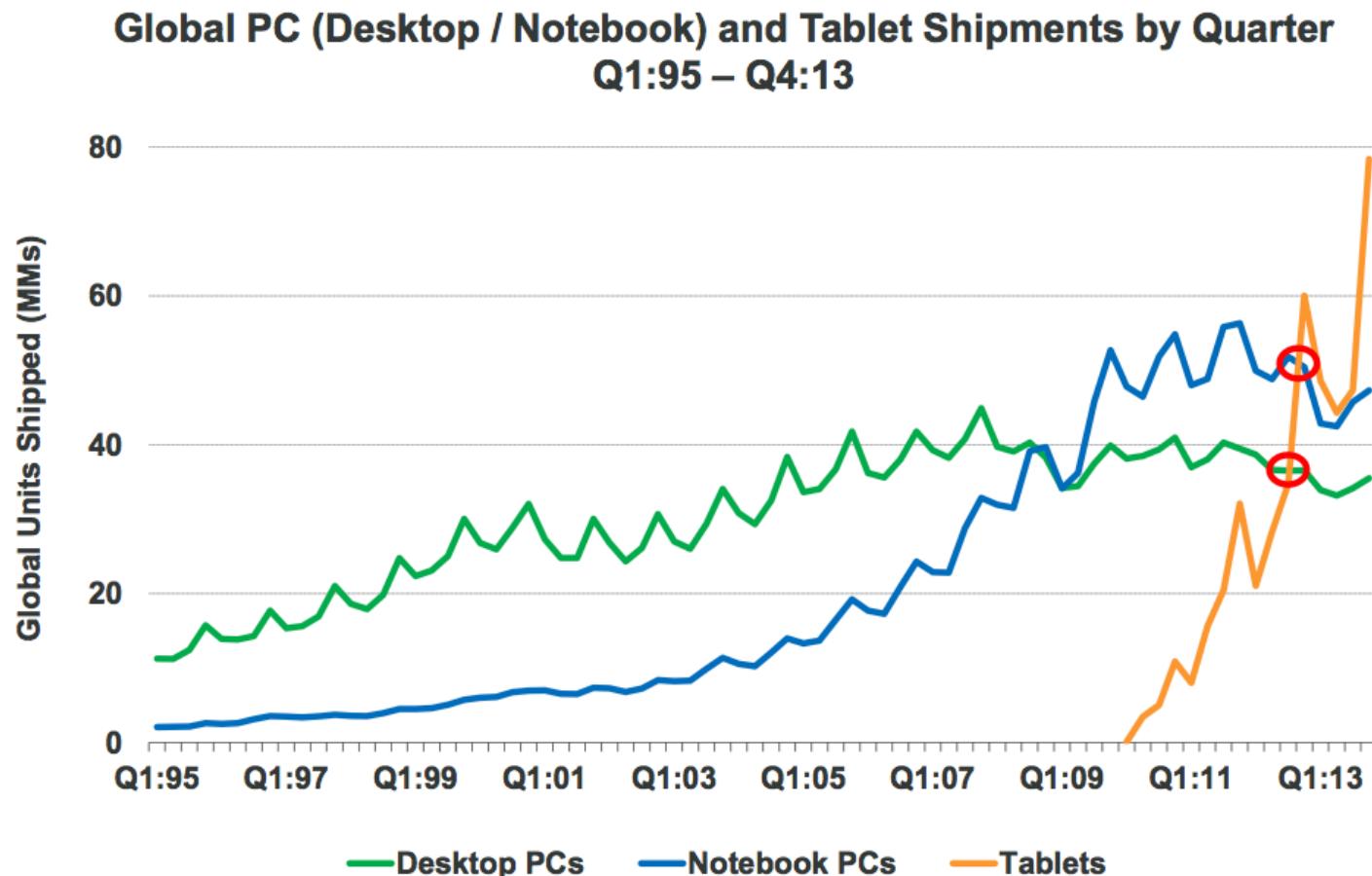


Source: Apple, as of CQ1:13 (12 quarters post iPad launch).
Launch Dates: iPhone (6/29/07), iPad (4/3/10).

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Tablet Units = Growing Faster Than PCs Ever Did... +52%, 2013



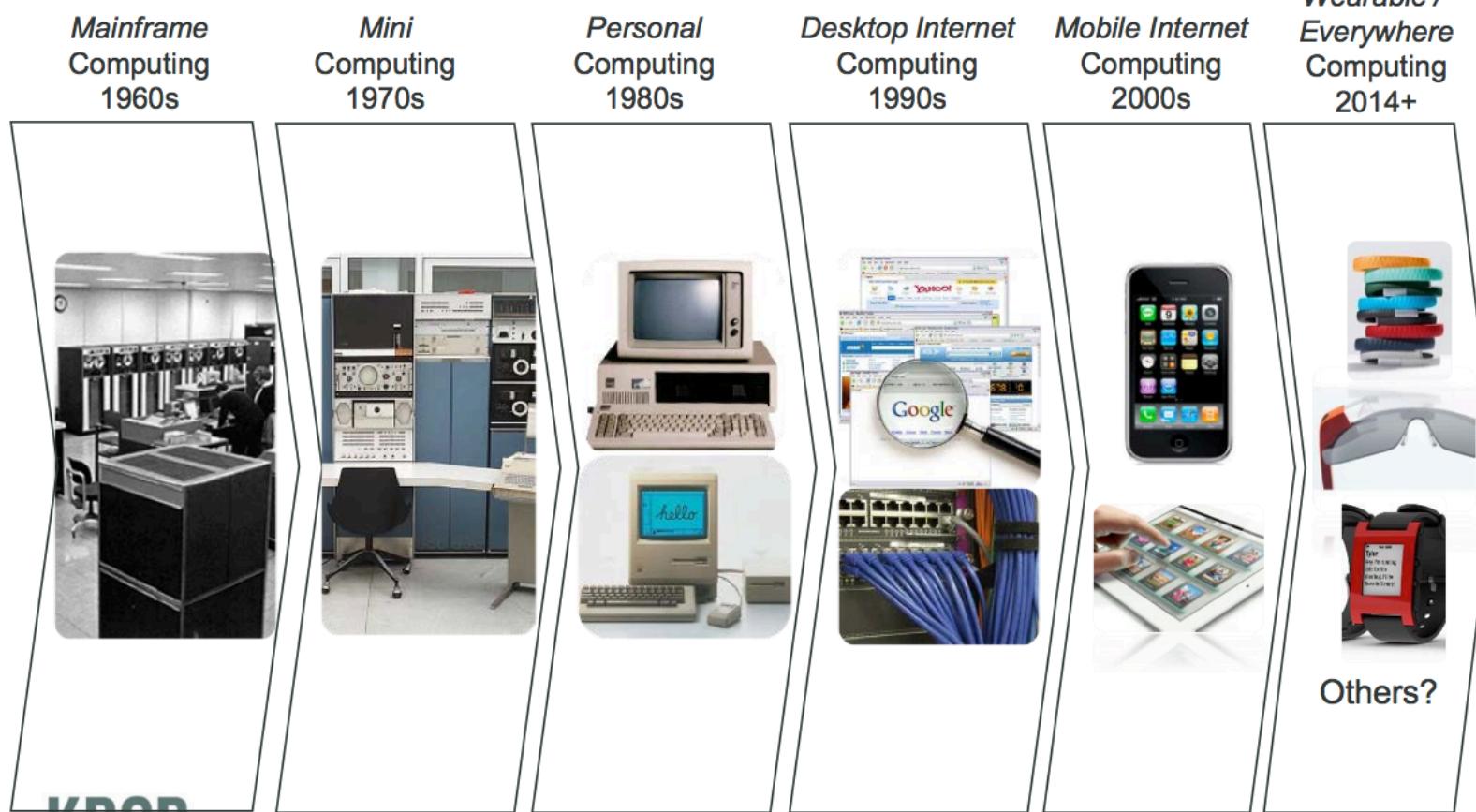
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Source: Morgan Stanley Research. Note: Notebook PCs include Netbooks.

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Technology Cycles – Still Early Cycle on Smartphones + Tablets, Now Wearables Coming on Strong, Faster than Typical 10-Year Cycle

Technology Cycles Have Tended to Last Ten Years



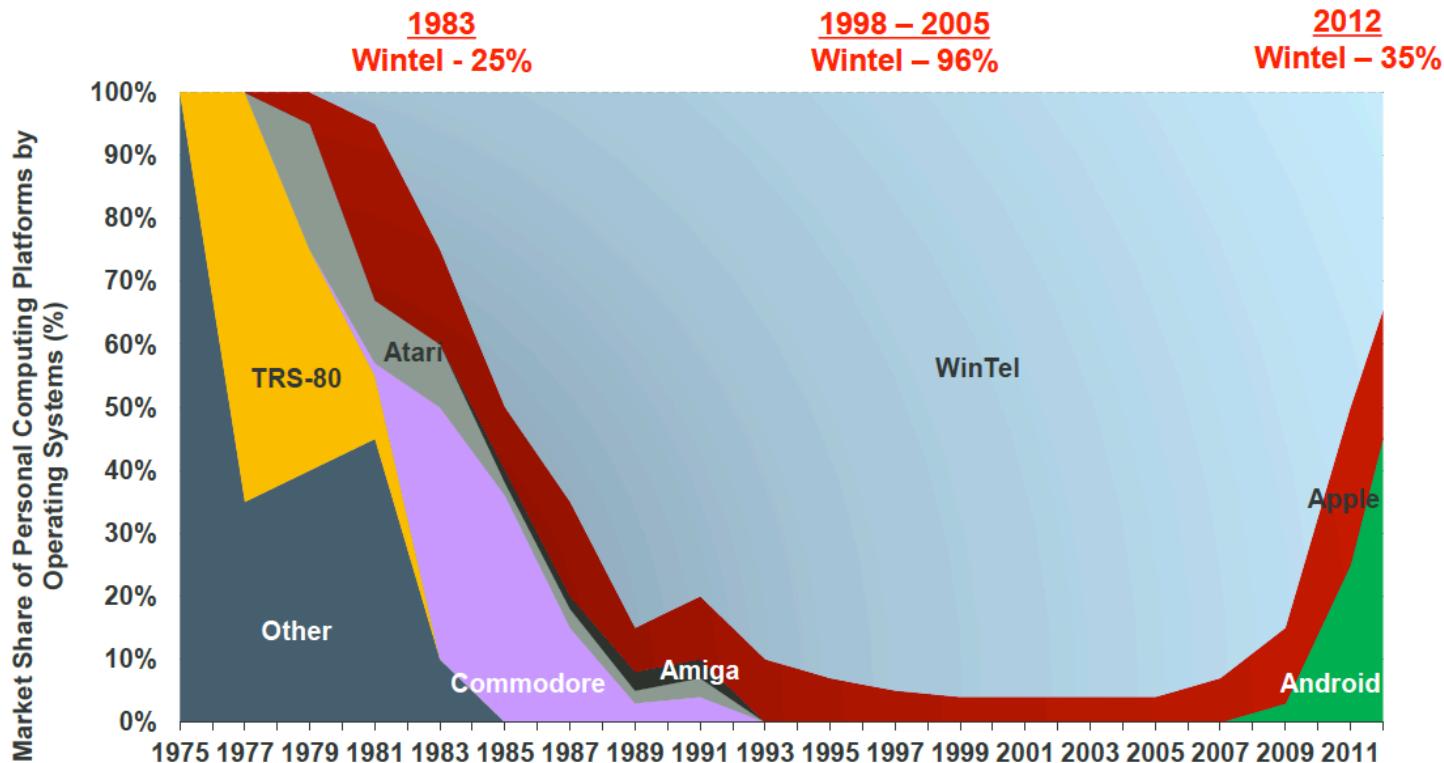
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Image Source: Computersciencelab.com, Wikipedia, IBM, Apple, Google, NTT docomo, Google, Jawbone, Pebble.

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Re-Imagination of Computing Operating Systems - iOS + Android = 60% Share vs. 35% for Windows

Global Market Share of Personal Computing Platforms by Operating System Shipments, 1975 – 2012



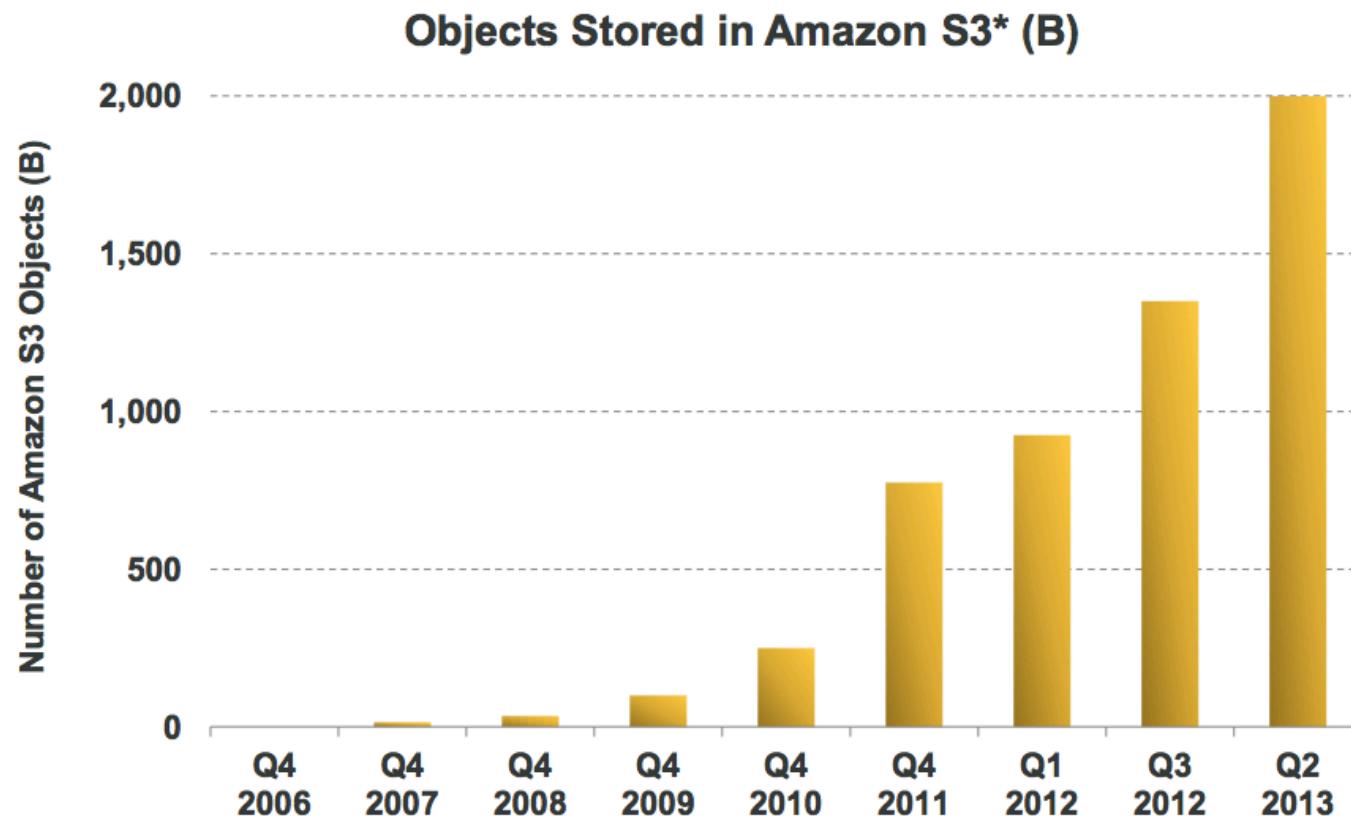
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Source: Asymco.com (as of 2011), Public Filings, Morgan Stanley Research, Gartner for 2012 data.

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...While The Cloud Rises

Amazon Web Services (AWS) Leading Cloud Charge...



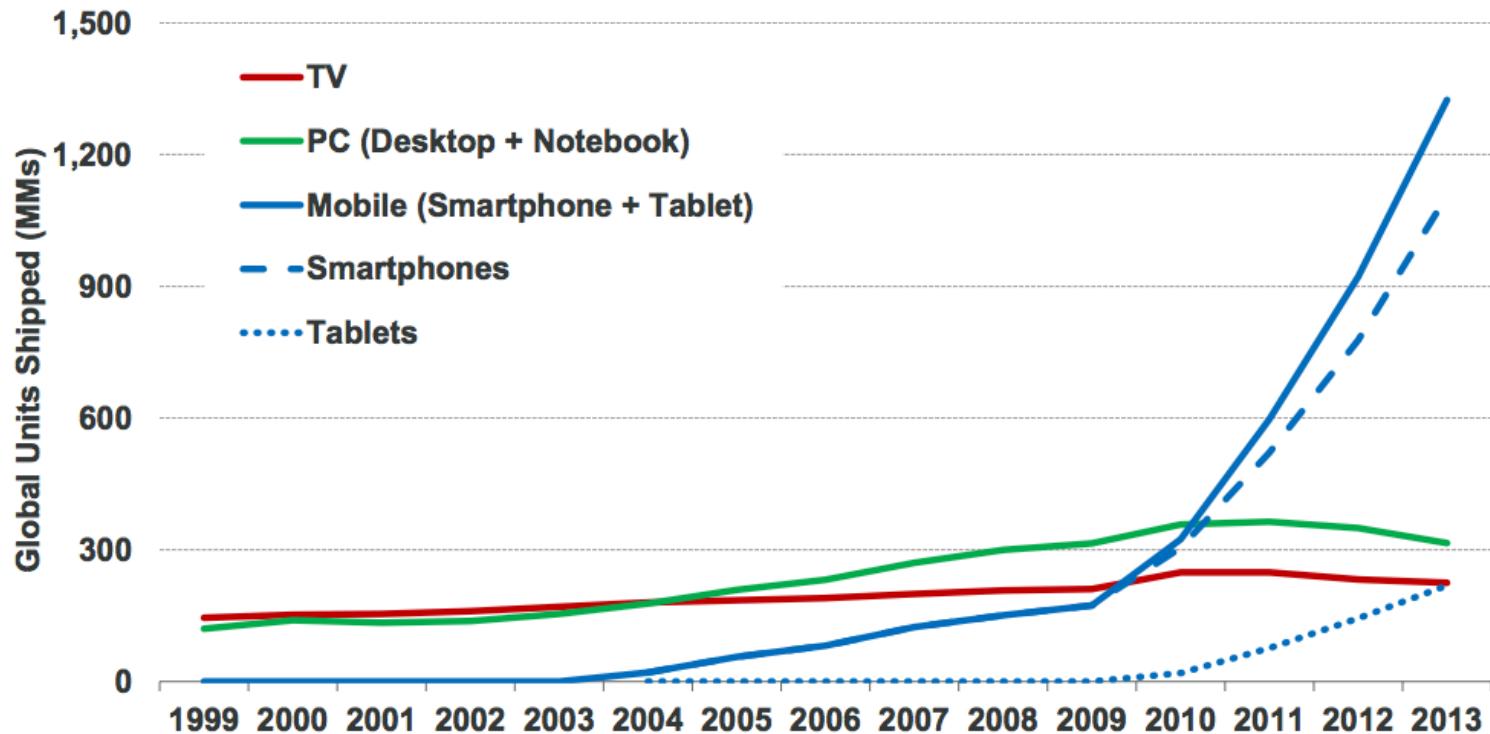
*Note: S3 is AWS' storage product and used as proxy for AWS scale / growth .
Source: Company data.



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Mobile (Smartphone + Tablet) Shipments = 4-5x Unit Volume of TV & PC...Just 10 Years Since Inception

Global TV vs. PC (Desktop + Notebook) vs.
Mobile (Smartphone + Tablet) Shipments, 1999 – 2013

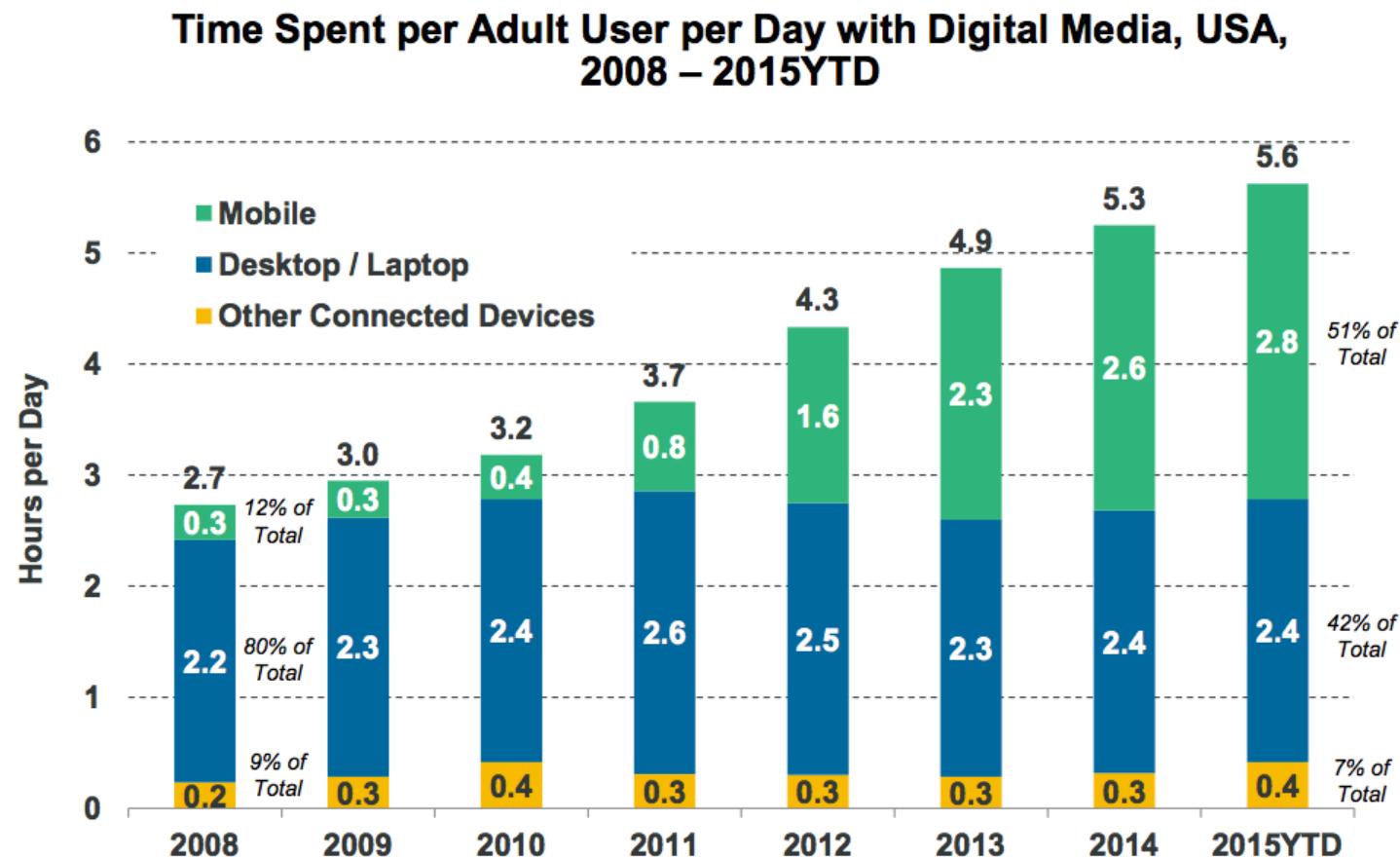


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Sources: TV unit shipments per NPD DisplaySearch (2004-2013 data) and Philips (1999-2003 data). PC (laptop + desktop) and smartphone + tablet unit shipments per Morgan Stanley Research.

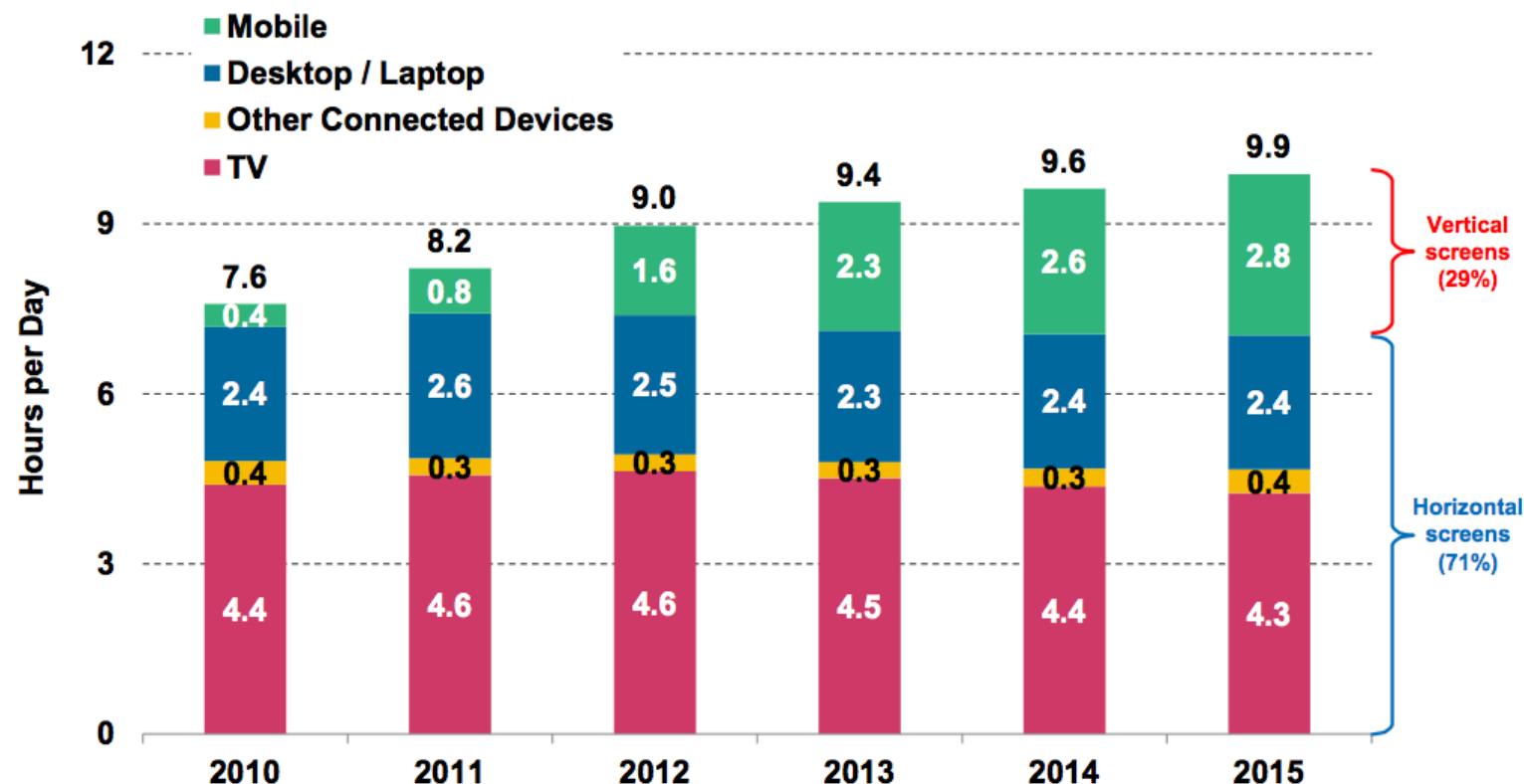
95

Internet Usage (Engagement) Growth Solid
+11% Y/Y = Mobile @ 3 Hours / Day per User vs. <1 Five Years Ago, USA



...Vertical Viewing = 29% of View Time (Multi-Platform) vs. 5% Five Years Ago, USA...

Time Spent on Screens by Orientation (Hours / Day), USA, 2010 – 2015



@KPCB

Source: eMarketer 4/15, Coate analysis. Note: Other connected devices include OTT and game consoles. Mobile includes smartphone and tablet. Usage includes both home and work. Ages 18+; time spent with each medium includes all time spent with that medium, regardless of multitasking; for example, 1 hour of multitasking on desktop/laptop while watching TV is counted as 1 hour for TV and 1 hour for desktop/laptop.

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Messaging Apps = Top Global Apps in Usage + Sessions

**6+ of Top 10
most used apps
globally =
Messaging Apps**

Top Apps by Usage

Rank	App	
①		Facebook
②		WhatsApp
③		Messenger
④		Instagram
⑤		LINE
⑥		Viber
⑦		KakaoTalk
⑧		Clash of Clans
⑨		WeChat
⑩		Twitter

Top Apps By Number of Sessions

Rank	App	Sessions	
①		KakaoTalk	55
②		WhatsApp	37
③		WeChat	29
④		VK	29
⑤		LINE	26
⑥		Viber	20
⑦		Facebook	20
⑧		Clash of Clans	16
⑨		Instagram	12
⑩		Messenger	8

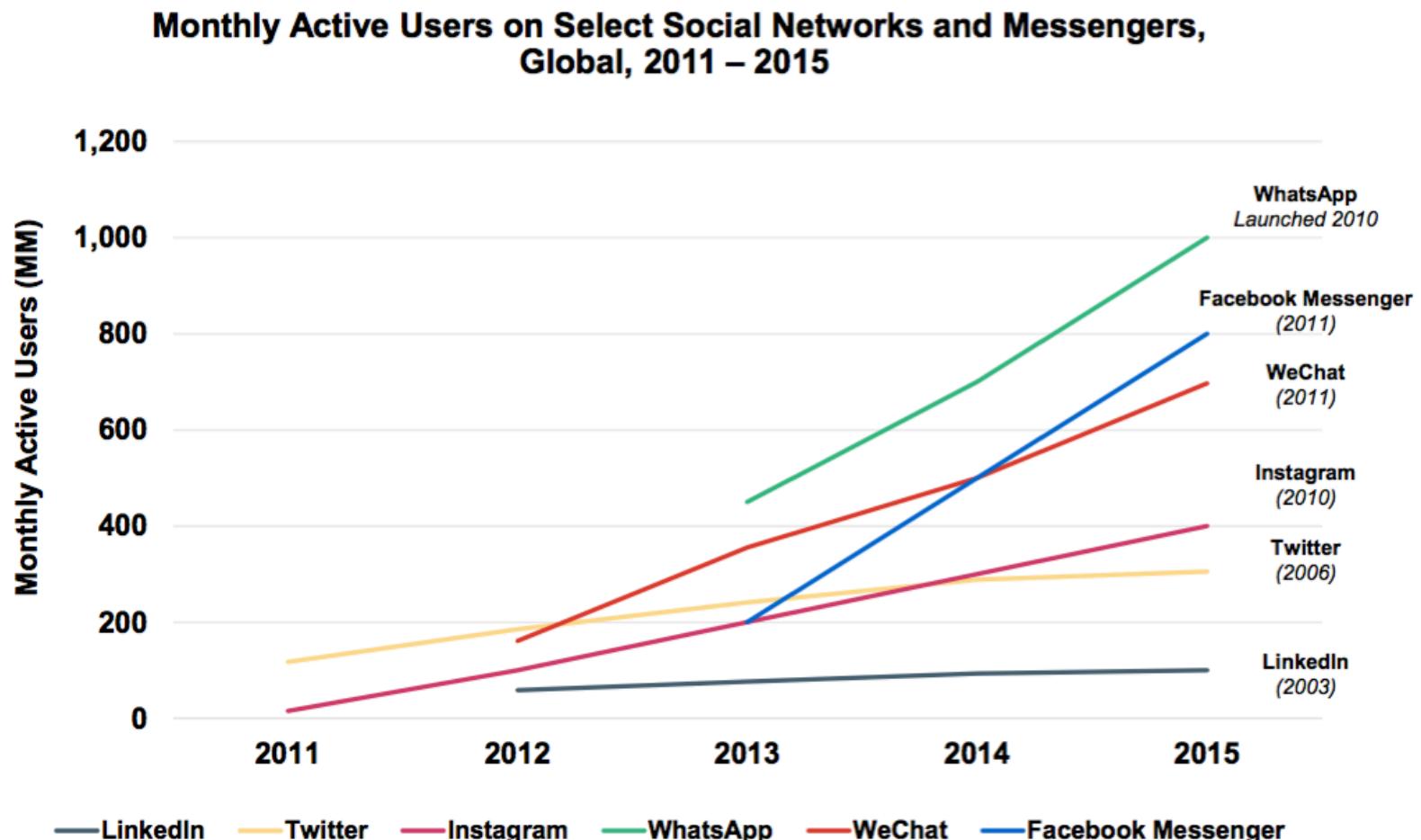
Messaging
Apps →
significant app
sessions



Source: Quettra, Q1:15. Data ranked based on usage.
Quettra analyzes 75MM+ Android users spread out in more than 150 countries, collecting install and usage statistics of every application present on the device. Q1:15 data analyzed three months of data starting from 1/1/15. Data excludes Google apps and other commonly pre-installed apps to remove biases. Only apps with 10K+ installs worldwide and 100+ DAU are counted.

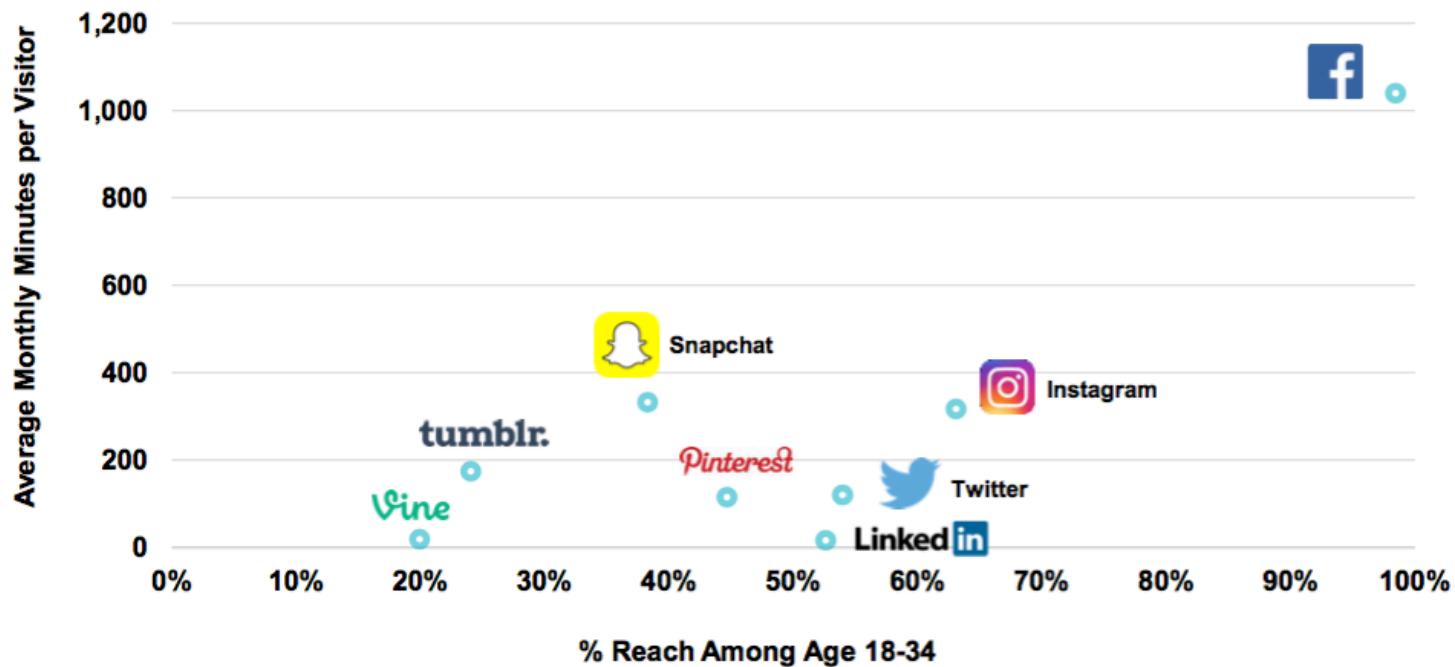
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Messaging Continues to Grow Rapidly... Leaders = WhatsApp / Facebook Messenger / WeChat



Millennial Social Network Engagement Leaders = Visual... Facebook / Snapchat / Instagram...

Age 18-34 Digital Audience Penetration vs.
Engagement of Leading Social Networks, USA, 12/15



Asia-Based Messaging Leaders = Continue to Expand Uses / Services Beyond Social Messaging

New Services Added 2015 -16*

Previous Existing Services



Name	KakaoTalk	WeChat	LINE
Launch	March 2010	January 2011	June 2011
Primary Country	Korea	China	Japan
Banking / Financial Services	Kakao Bank (11/15)	WeBank (1/15)	Debit Card (2016)
Enterprise	x	Enterprise WeChat (3/16)	x
Online-To-Offline (O2O)	Kakao Hairshop (1H:16E) Kakao Driver (1H:16E)	✓	Grocery Delivery (2015)
TV	Kakao TV (6/15)	✓	Line Live & Line TV (2015)
Video Calls / Chat	(6/15)	✓	✓
Taxi Services	Kakao Taxi (3/15)	✓	✓
Messaging	✓	✓	✓
Group Messaging	✓	✓	✓
Voice Calls	Free VoIP calls (2012)	WeChat Phonebook (2014)	✓
Payments	KakaoPay (2014)	(2013)	Line Pay (2014)
Stickers	(2012)	Sticker shop (2013)	(2011)
Games	Game Center (2012)	(2014)	(2011)
Commerce	Kakao Page (2013)	Delivery support w / Yixin (2013)	Line Mall (2013)
Media	Kakao Topic (2014)	✓	✓
QR Codes	✓	QR code identity (2012)	✓
User Stories / Moments	Kakao Story (2012)	WeChat Moments	Line Home (2012)
Developer Platform	KakaoDevelopers	WeChat API	Line Partner (2012)

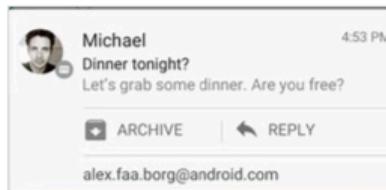
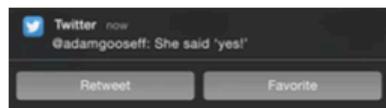
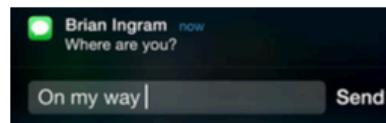
Average Global Mobile User = ~33 Apps...12 Apps Used Daily... 80% of Time Spent in 3 Apps

Day in Life of a Mobile User, 2016

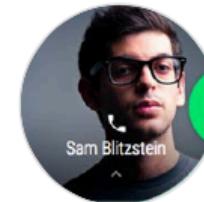
	Average # Apps Installed on Device*	Average Number of Apps Used Daily	Average Number of Apps Accounting for 80%+ of App Usage	Time Spent on Phone (per Day)	Most Commonly Used Apps
USA	37	12	3	5 Hours	Facebook Chrome YouTube
Worldwide	33	12	3	4 Hours	Facebook WhatsApp Chrome

Notifications = Growing Rapidly & Increasingly Interactive... Driving New Touch Points with Messaging Platforms + Other Apps

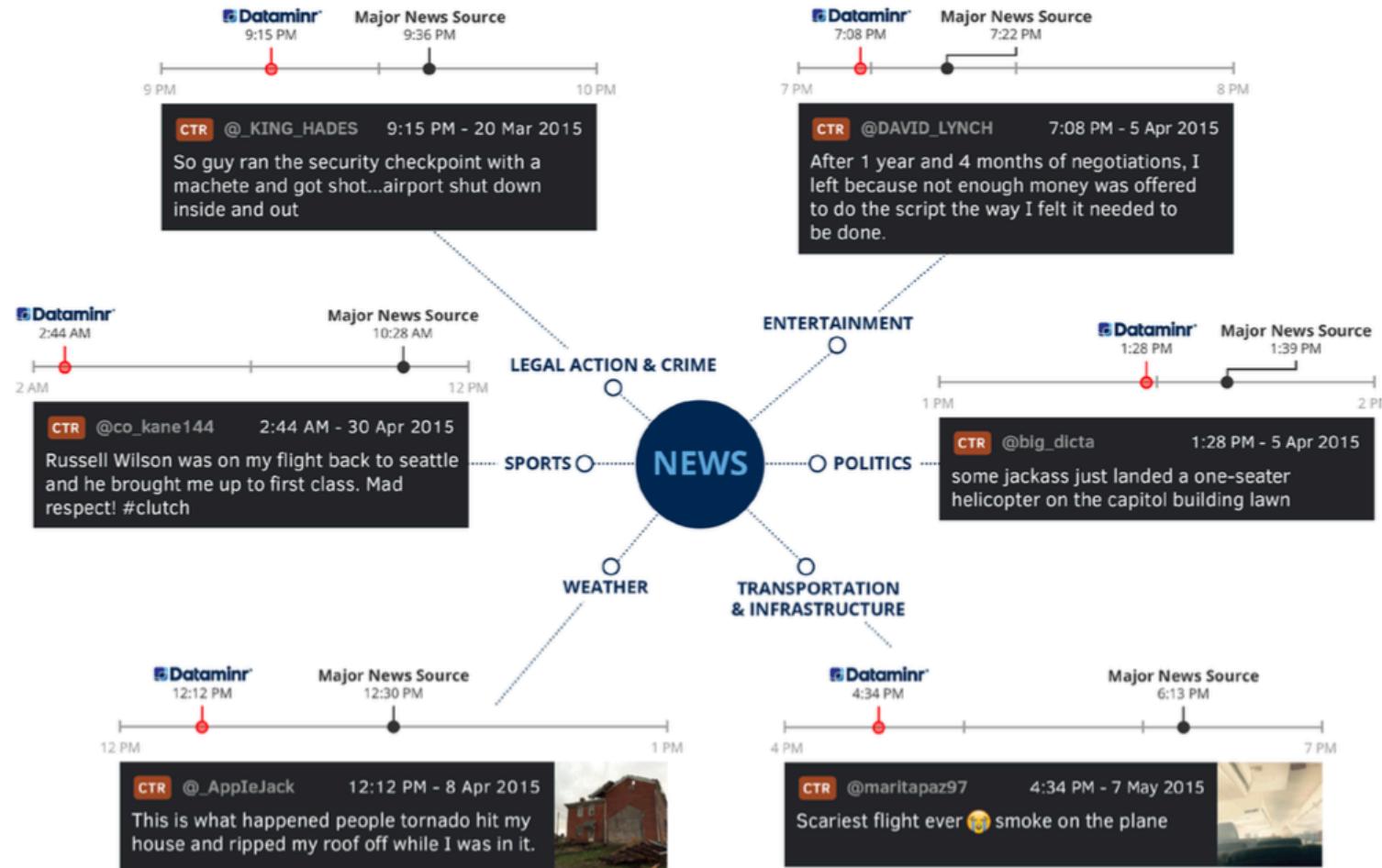
**Direct Interaction
on Notification Panel –**
without users interrupting
what they're doing...



...More Up Close & Personal –
as notifications appear on more
& more mobile devices



Users Increasingly First Source for News via Twitter / Dataminr



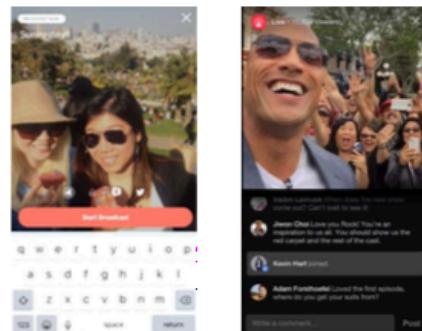
@KPCB

Source: Dataminr, 5/15.

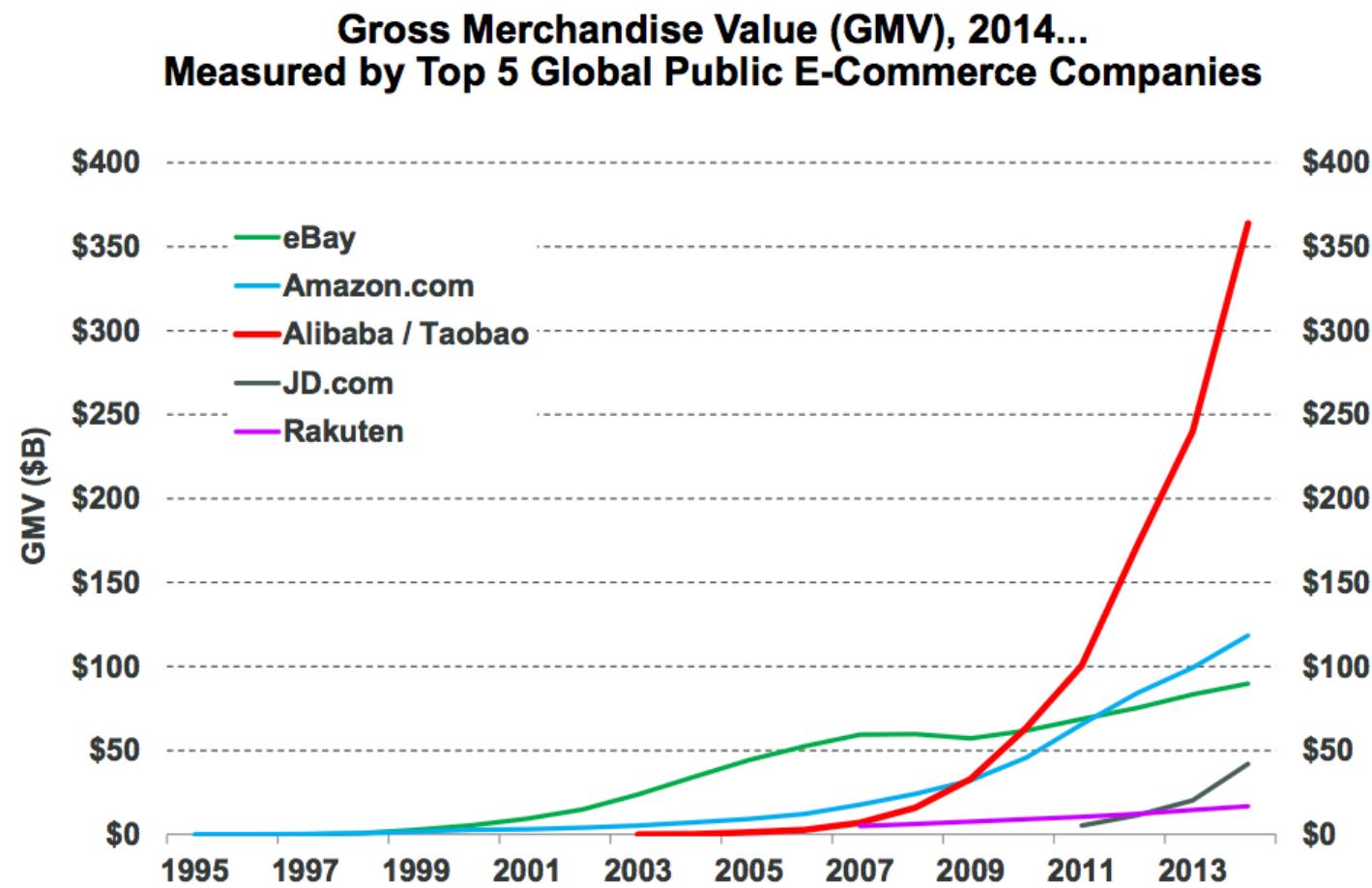
65

Video Evolution = Accelerating

Live (Linear) → On-Demand → Semi-Live → Real-Live

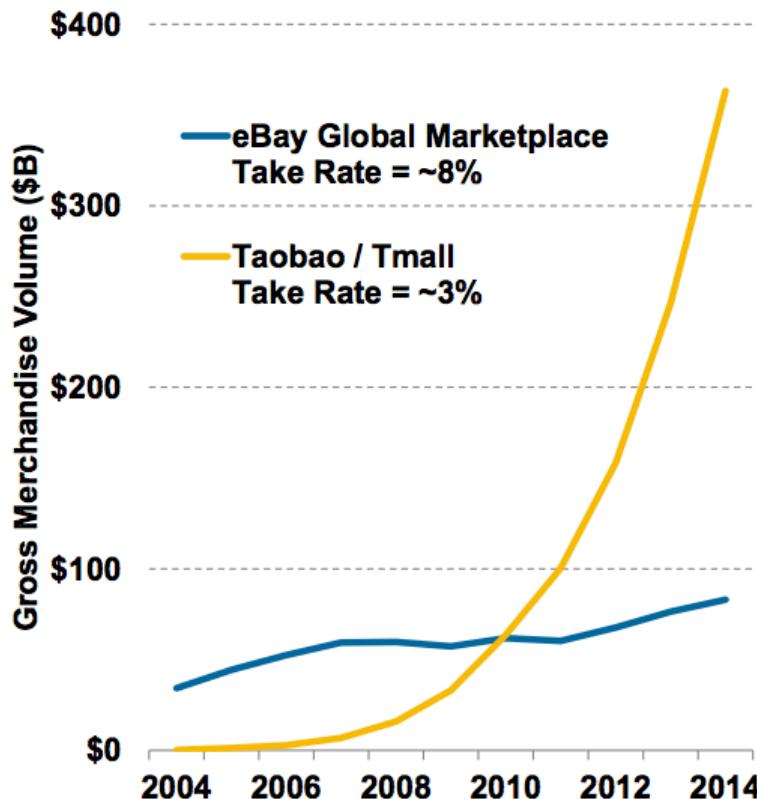
Live (Linear)	On-Demand	Semi-Live	Real-Live
<i>Traditional TV 1926</i>	<i>DVR / Streaming 1999</i>	<i>Snapchat Stories 2013</i>	<i>Periscope + Facebook Live 2015 / 2016</i>
Tune-In or Miss Out	Watch on Own Terms	Tune-In Within 24 Hours or Miss Out	Tune-In / Watch on Own Terms
Mass Concurrent Audience	Mass Disparate Audience	Mostly Personal Audience	Mass Audience, yet Personal
Real-Time Buzz	Anytime Buzz	Anytime Buzz	Real Time + Anytime Buzz
	 		

1st Generation 'Online Platforms / Marketplaces for *Products* Rising =
Optimized for Desktop Internet + Traditional Shipping Delivery

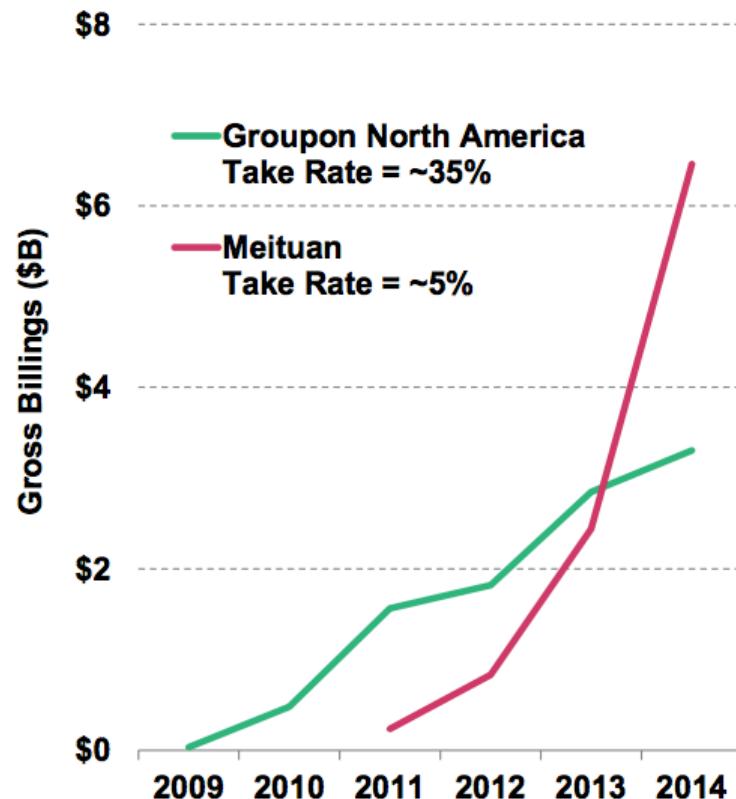


China E-Commerce = Low Take Rates* Helped China Marketplace Leaders Pass USA Peers

Gross Merchandise Value, 2004 – 2014
eBay vs. Alibaba (Taobao / Tmall)



Gross Billings, 2009 – 2014
Groupon N. America vs. Meituan



@KPCB

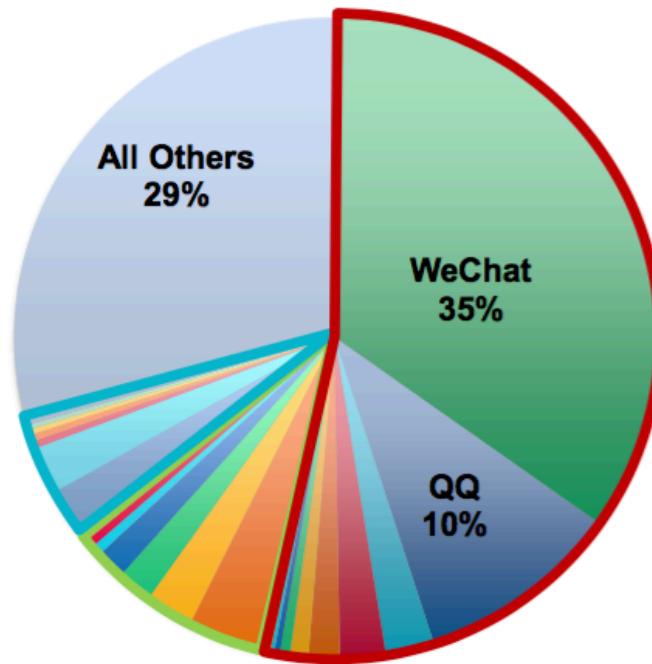
Source: Meituan gross billings data are estimates by Tuan800.com, eBay, Groupon, Alibaba GMV data per company.
Note: Take rate defined as net revenue divided by gross merchandise value or gross billings. eBay marketplace take rate excludes PayPal (~3%),
eBay, Alibaba GMV data per company. Meituan take rate is estimate per media report.

Hillhouse Capital
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China Mobile Internet Usage Leaders...

Tencent + Alibaba + Baidu = 71% of Mobile Time Spent

Share of Mobile Time Spent, April 2016
Daily Mobile Time Spent = ~200 Minutes per User, Average



Tencent

- WeChat
- QQ
- QQ Browser
- Tencent Video
- Tencent News
- Tencent Games
- QQ Music
- JD.com
- QQ Reading

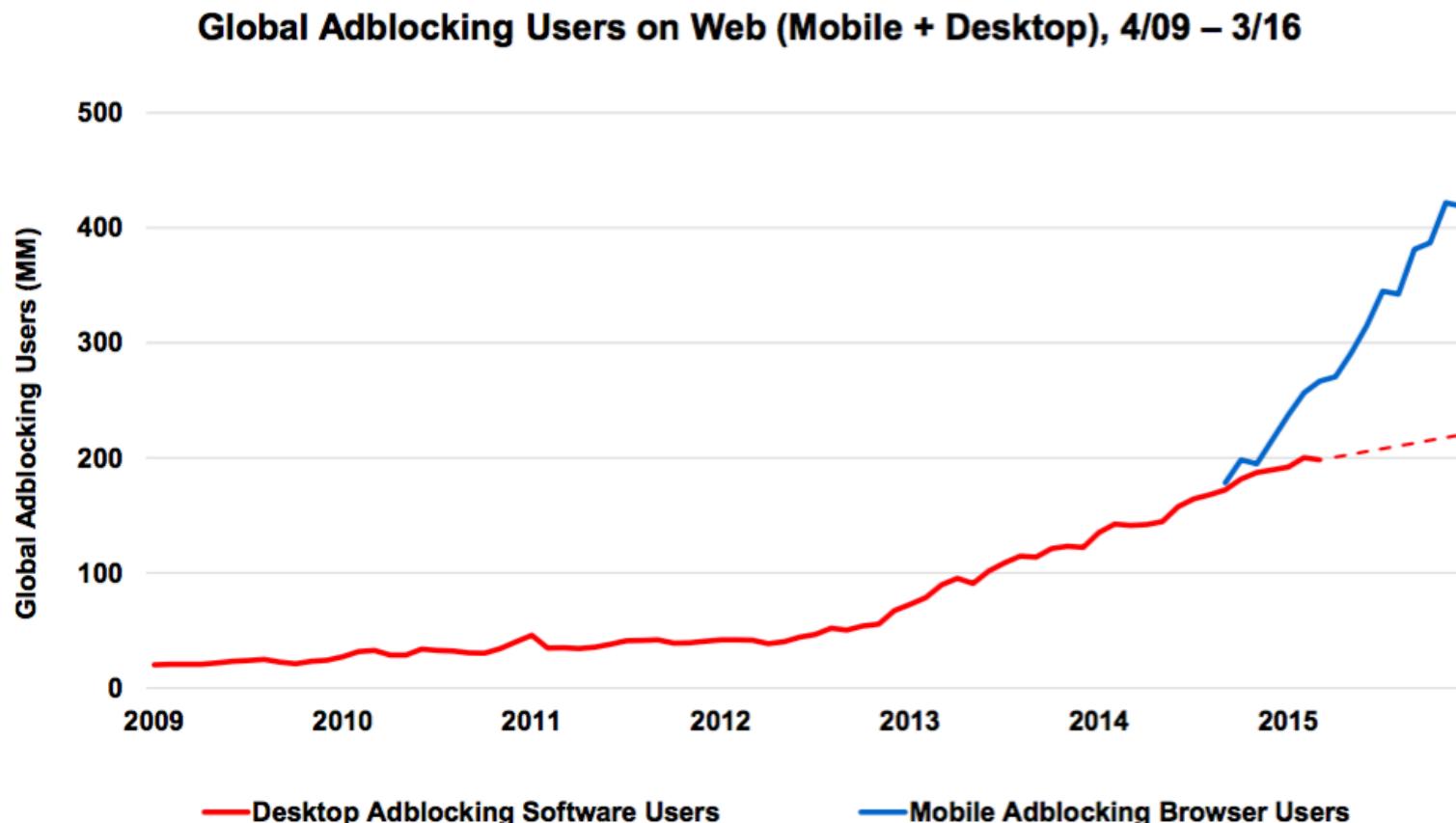
Alibaba

- UCWeb Browser
- Taobao
- Weibo
- YouKu Video
- Momo
- Shuqi Novel
- AliPay
- AutoNavi

Baidu

- Mobile Baidu
- iQiyi / PPS Video
- Baidu Browser
- Baidu Tieba
- 91 Desktop
- Baidu Maps
- All Other

Adblocking @ ~220MM Desktop Users (+16% Y/Y)...~420MM+ Mobile (+94%)...
Majority in China / India / Indonesia = Call-to-Arms to Create Better Ads, per PageFair



Source: PageFair, 5/16. Dotted line represents estimated data. These two data sets have not been de-duplicated. The number of desktop adblockers after 6/15 are estimates based on the observed trend in desktop adblocking and provided by PageFair. Note that mobile adblocking refers to web / browser-based adblocking and not in-app adblocking. Desktop adblocking estimates are for global monthly active users of desktop adblocking software between 4/09 – 6/15, as calculated in the PageFair & Adobe 2015 Adblocking Report. Mobile adblocking estimates are for global monthly active users of mobile browsers that block ads by default between 9/14 – 3/16, including the number of Digicel subscribers in the Caribbean (added 10/15), as calculated in the PageFair & Priori Data 2016 Adblocking Report.

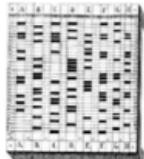
@KPCB

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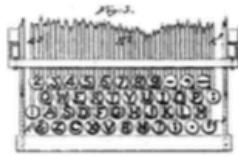
Internet Continues to Ramp as Retail Distribution Channel = 10% of Retail Sales vs. <2% in 2000



Human-Computer Interaction (1830s – 2015), USA = Touch 1.0 → Touch 2.0 → Touch 3.0 → Voice



Punch Cards for
Informatics
1832



QWERTY
Keyboard
1872



Electromechanical
Computer (Z3)
1941



Electronic Computer
(ENIAC)
1943



Paper Tape Reader
(Harvard Mark I)
1944



Mainframe Computers
(IBM SSEC)
1948



Trackball
1952



Joystick
1967



Microcomputers
(IBM Mark-8)
1974



Portable Computer
(IBM 5100)
1975



Commercial Use of
Window-Based GUI
(Xerox Star)
1981



Commercial Use
of Mouse
(Apple Lisa)
1983



Commercial Use
of Mobile
Computing
(PalmPilot)
1996



Touch + Camera -
based Mobile
Computing
(iPhone 2G)
2007



Voice on Mobile
(Siri)
2011

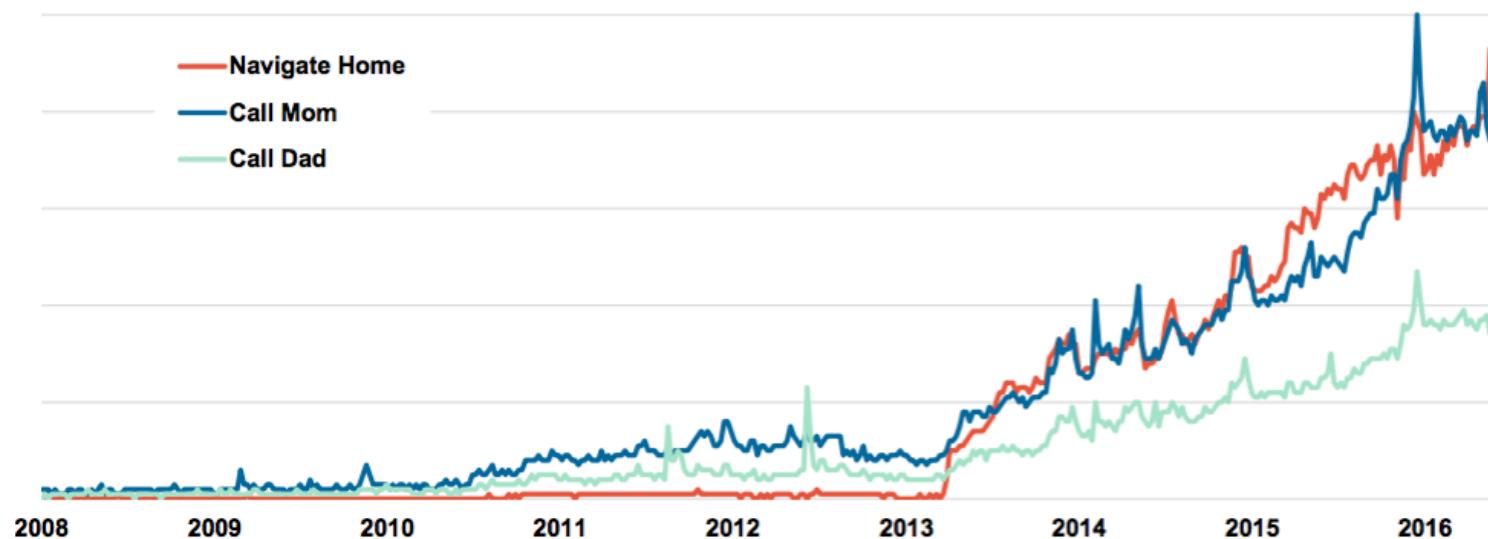


Voice on Connected /
Ambient Devices
(Amazon Echo)
2014

Google Voice Search Queries = Up >35x Since 2008 & >7x Since 2010, per Google Trends

Google Trends imply queries associated with voice-related commands have risen >35x since 2008 after launch of iPhone & Google Voice Search

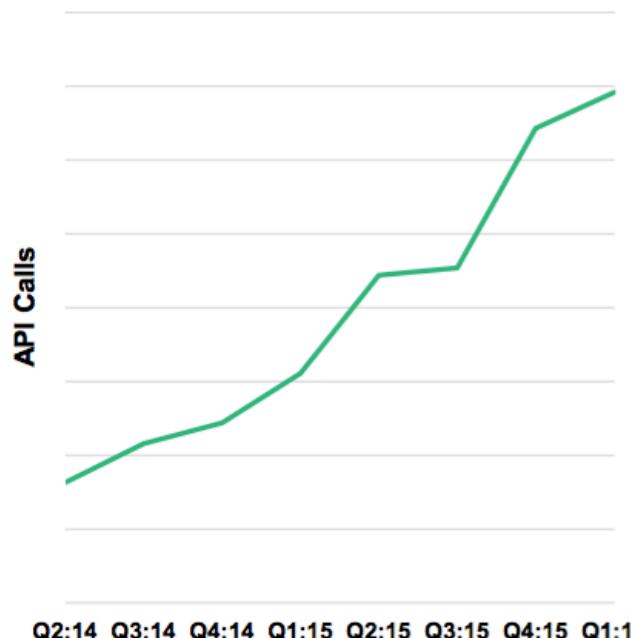
Google Trends, Worldwide, 2008 – 2016



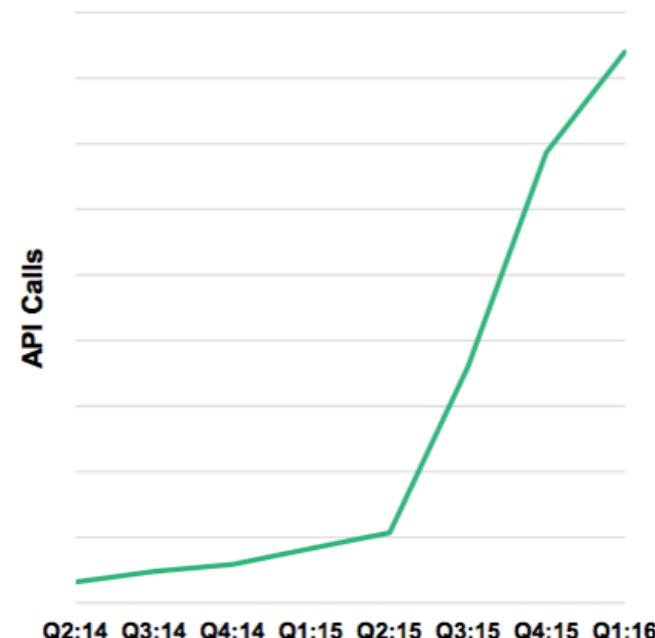
Baidu Voice = Input Growth >4x...Output >26x, Since Q2:14

Usage across all Baidu products growing rapidly...typing Chinese on small cellphone keyboard even more difficult than typing English...Text-to-Speech supplements speech recognition & key component of man-machine communications using voice

**Baidu Speech Recognition Daily Usage by API Calls,
Global, 2014 – 2016¹**



**Baidu Text to Speech (TTS) Daily Usage by API Calls,
Global, 2014 – 2016²**



Source: Baidu
Note: (1) Data shown is growth of speech recognition at Baidu, as measured by the number of API calls to Baidu's speech recognition system across time, from multiple products. Most of these API calls were for Mandarin speech recognition. (2) Data shown is growth of TTS (text to speech) at Baidu, in terms of the total number of API calls to Baidu's TTS system across time, from multiple products. Most of these API calls were for Mandarin TTS.



Is it a Car...Is it a Computer?...

Is it a Phone...Is it a Camera?



Is it a Car...Is it a Computer?



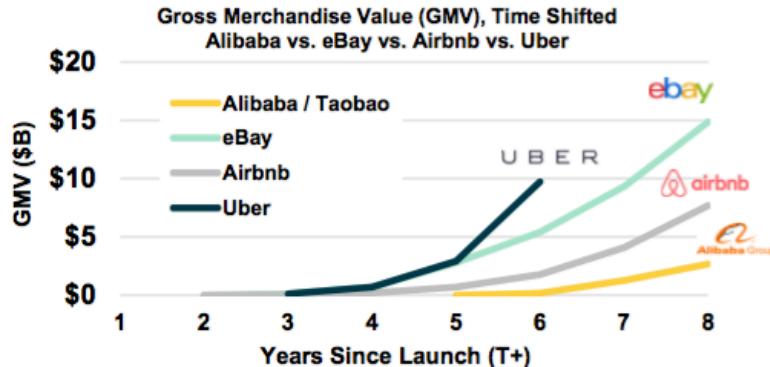
...One Can...

Lock / Monitor / Summon One's Tesla from One's Wrist



Current Generation of Internet Leaders = Growing Faster than Previous Generation

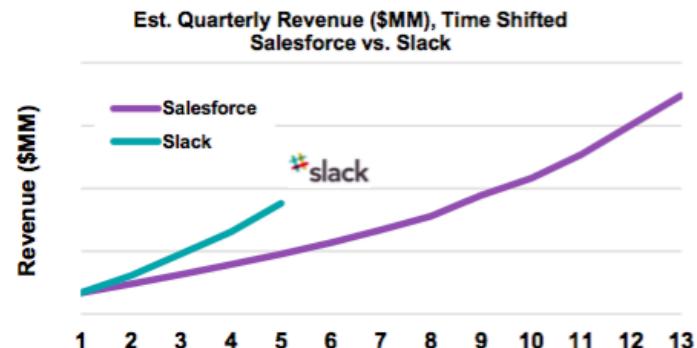
Marketplaces



Commerce



Enterprise



Global Internet Market Leaders = Apple / Google / Amazon / Facebook / Tencent / Alibaba...Flush with Cash...Private Companies Well Represented

Rank	Company	Region	Current Market Value (\$B)	Q1:16 Cash (\$B)	2015 Revenue (\$B)
1	Apple	USA	\$547	\$233	\$235
2	Google / Alphabet	USA	510	79	75
3	Amazon	USA	341	16	107
4	Facebook	USA	340	21	18
5	Tencent	China	206	14	16
6	Alibaba	China	205	18	15
7	Priceline	USA	63	11	9
8	Uber	USA	63	--	--
9	Baidu	China	62	11	10
10	Ant Financial	China	60	--	--
11	Salesforce.com	USA	57	4	7
12	Xiaomi	China	46	--	--
13	Paypal	USA	46	6	9
14	Netflix	USA	44	2	7
15	Yahoo!	USA	36	10	5
16	JD.com	China	34	5	28
17	eBay	USA	28	11	9
18	Airbnb	USA	26	--	--
19	Yahoo! Japan	Japan	26	5	5
20	Didi Kuaidi	China	25	--	--
Total			\$2,752	\$447*	\$554*

@KPCB

Source: CapIQ, CB Insights, Wall Street Journal, media reports. Market value data as of 5/31/16. * Includes only public companies.
 Note: For public companies, colors denote current market value relative to Y/Y market value. Green = higher. Red = lower. Purple = newly public within last 12 months (applied here to both eBay and Paypal given Paypal spinoff on 7/20/15). Yellow = private companies, where market value represents latest publicly announced valuation. Ant Financial and Didi Kuaidi valuation per latest media reports as of 5/2016. Ant Financial treated separately from Alibaba as Alibaba retains no control of Ant and will receive a capped lump sum payment in the event of an Ant liquidity event. Cash includes cash and equivalents and short-term marketable securities plus long-term marketable securities where deemed liquid.

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IoT is ...

a proposed development of the Internet in which everyday objects have network connectivity, allowing them to send and receive data.

Google Definition

The Internet of Things (**IoT**) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment.

Gartner

The Internet of Things (**IoT**) has been defined in Recommendation [ITU-T.Y.2060](#) (06/2012) as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

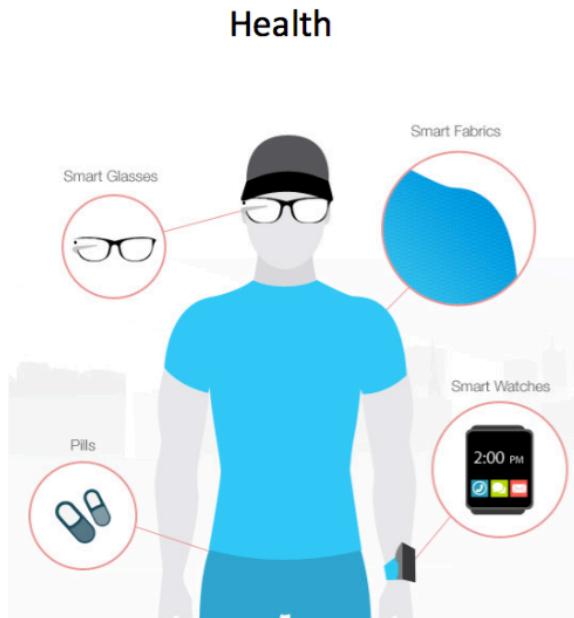
ITU

[6 slides from Al Brown, CTO of 1 For 1]

Types of IoT



Consumer

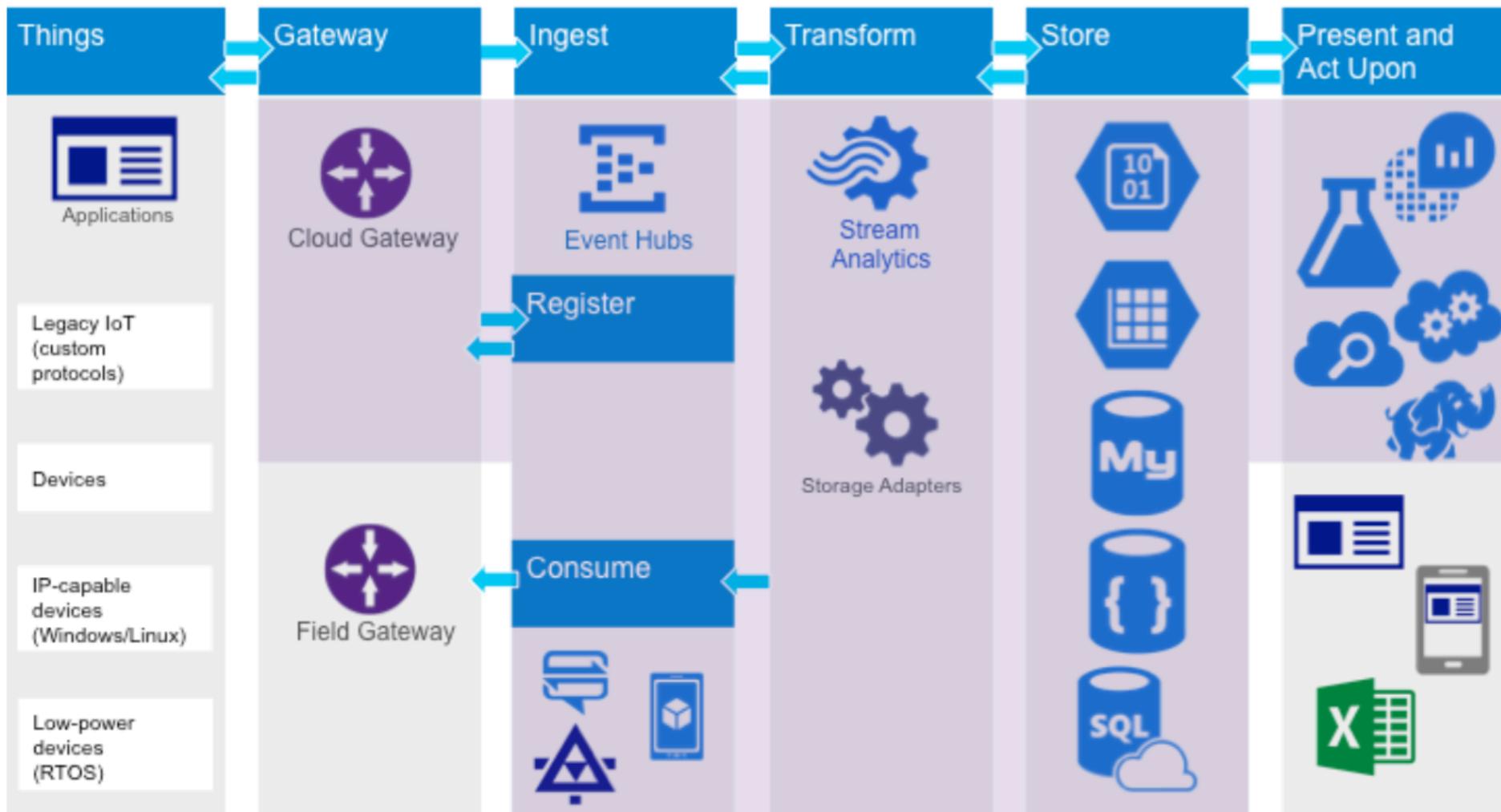


Health



Industrial

(NORMAL) IoT Layers



IoT Protocols

Networks and protocols are mostly not reliable and slow. Plan for it.

Device/Thing to Gateway:

- ZigBee - Wireless sensors
- BLE – Wireless sensors
- ModBus (Serial or TCP)

Gateway to Server:

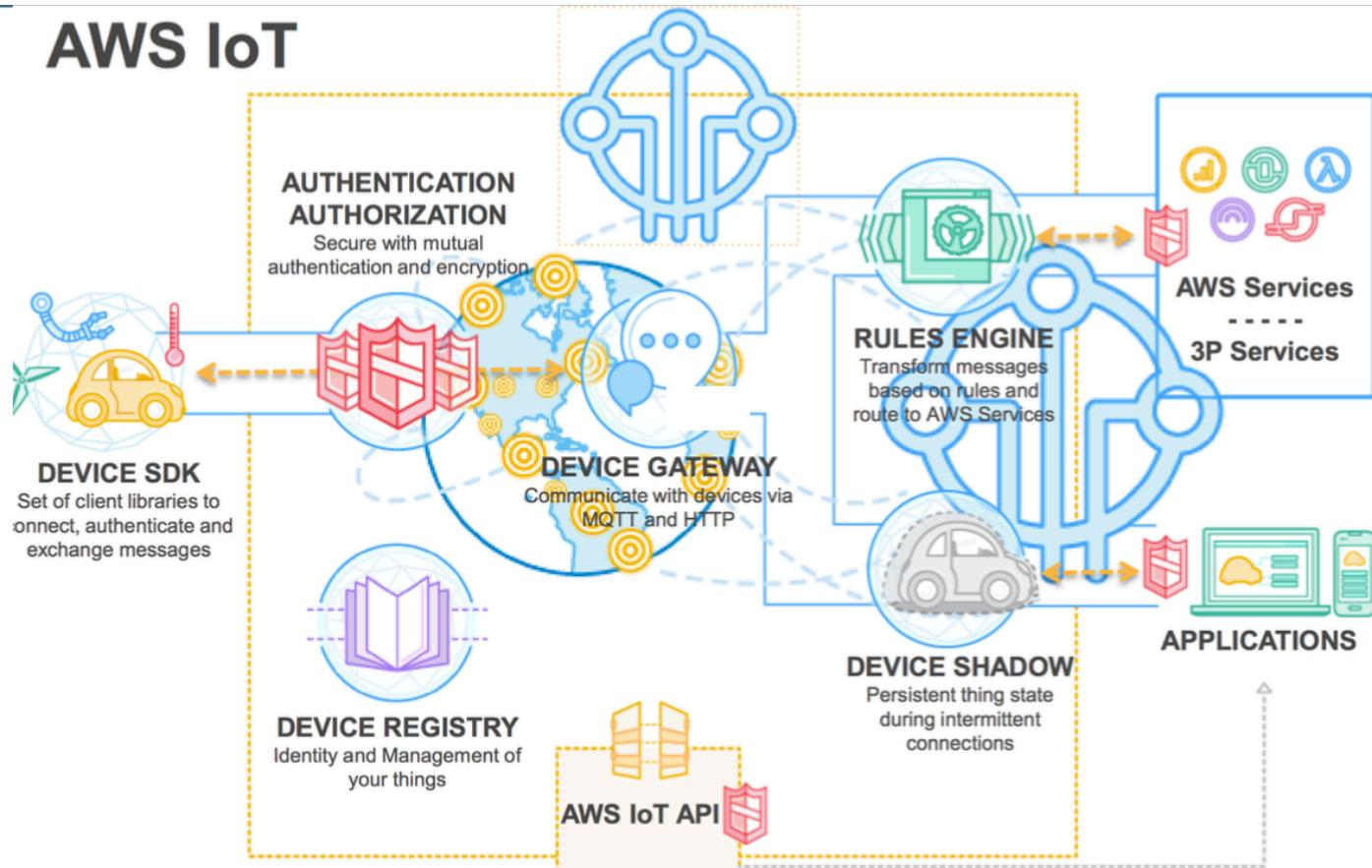
- ModBus TCP – Common
- OPC - Common for industrial assets
- HTTP – JSON over HTTP
- MQTT - Consumer oriented, promising

IoT Platforms

- Amazon IoT
 - Physical/Shadow Device (Persisted JSON State)
 - MQTT Endpoint
 - Rules
 - AWS Connectivity
- GE Predix 2.0 (PaaS)
 - CloudFoundry, HDP
 - Asset Model, Machine Connectivity, Time Series DB, Analytics Plugin (BPMN)
- PTC ThingWorx
 - Originally HMI for TCP-connected devices
- Xively
 - Device connectivity, time series database, connectivity to applications
 - Popular with Arduino developers

AWS IoT

AWS IoT



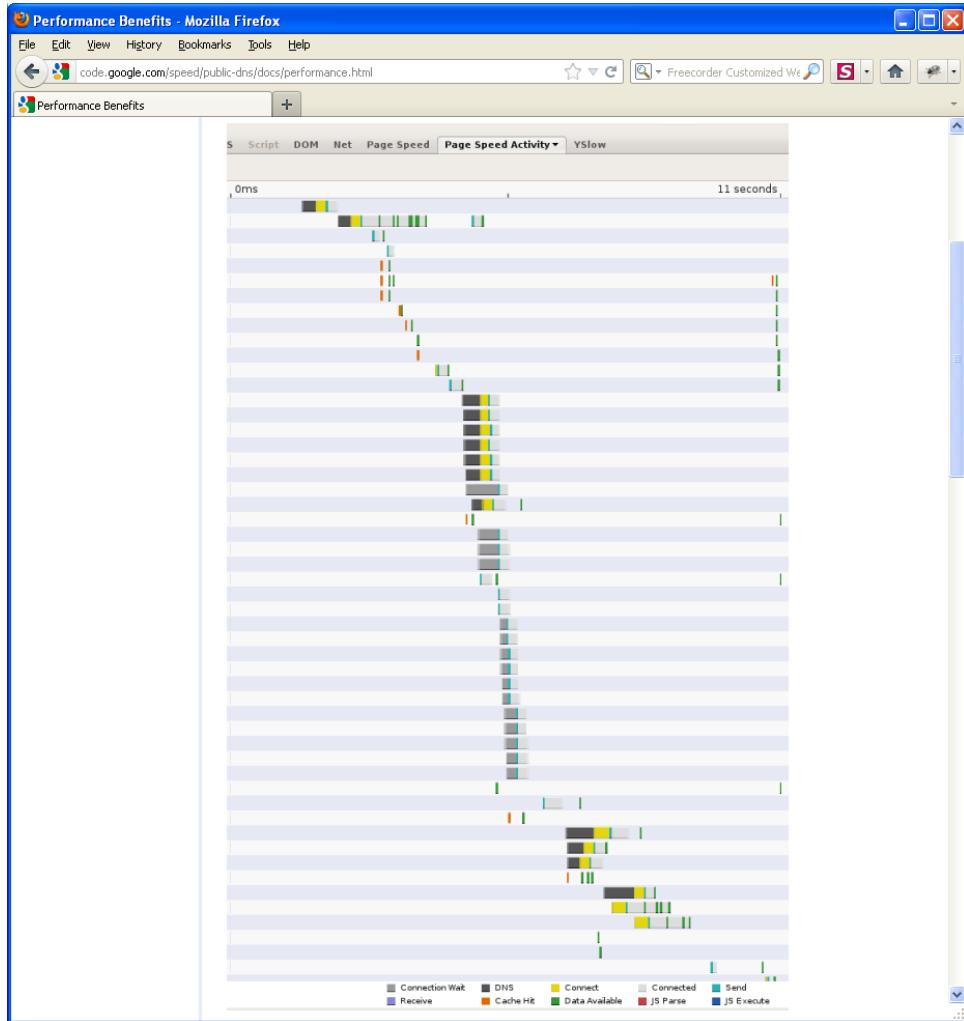
Domain Name System

- Lets focus on one important aspect of the Internet, the domain name system

DNS (Domain Name System) Resolution

- The DNS protocol is an important part of the web's infrastructure
- Every time you visit a website, your computer performs a DNS lookup
- Complex pages often require multiple DNS lookups before they start loading, so your computer may be performing hundreds of lookups a day
- DNS latency is mainly due to
 - The round-trip time to make the request and get the response, due to network congestion, overloaded servers, denial-of-service attacks
 - Cache misses which cause recursive querying of other name servers
- Google has introduced **Google Public DNS**
 - Configure your network to use 8.8.8.8 and 8.8.4.4
 - Google handles more than 70 billion requests *a day!*
 - Google also has IPv6 addresses
 - 2001:4860:4860::8888 and 2001:4860:4860::8844
 - <http://code.google.com/speed/public-dns/docs/intro.html>
- Another alternative is **opendns.com**
 - They have a global network of DNS resolvers to speed resolution
 - The base service is free, but upgrades cost

DNS Resolution is a Critical Component of Efficient Web Page Downloading



<http://code.google.com/speed/public-dns/docs/performance.html>

Internet Domain Names

- The Domain Name System is a mapping to/from IP addresses to domain names
 - defined in RFC 1034, 1035, see e.g.
 - <http://www.faqs.org/rfcs/rfc1035.html>
 - Invented in 1983 by Paul Mockapetris **while at USC**, see http://en.wikipedia.org/wiki/Domain_name_system
- There are 13 top level root name servers, see http://en.wikipedia.org/wiki/Root_name_server
- Founded in 1998, ICANN is the organization in charge of maintaining the DNS system, see www.icann.com



Internet Corporation for Assigned Names and Numbers

Top Level Domain Names

- **In 1984** Top level domains were **originally** divided into the following logical categories
 - com commercial and industrial organizations
 - edu educational institutions
 - gov non-military, government affiliated organizations
 - mil military organizations
 - net network operations
 - org other organizations and user groups
- **In 2001** new top level domains were added
 - .biz, .info, .name, .museum, .coop, .aero, .pro, .xxx
 - www.internic.net/faqs/new-tlds.html
- **In 2009** ICANN agreed to accept internationalized domain names, encoded as Unicode. See:
 - <http://www.icann.org/en/resources/idn/fast-track>
- **In 2011** ICANN announced a huge expansion of TLDs, giving requirements for anyone wanting to establish one
 - As of 9/12 they have received 2,000 applications
 - <http://www.icann.org/en/news/announcements/announcement-13jun12-en.htm>

Domain Name Statistics

Distribution of Top-Level Domain Names
by Host Count, July2015,
at <http://ftp.isc.org/www/survey/reports/2015/07/bynum.txt>

Domain	Hosts = All Hosts	- Dup Names	Level 2 Domains	Level 3 Domains	
TOTAL	1033836245	1111945678	78109433	5075997	136518652
net	390568793	401935276	11366483	385390	69620288 Networks
com	139757928	174261091	34503163	2902986	2599122 Commercial
jp	76853538	77035243	181705	63768	909012 Japan
de	46152418	46344741	192323	183246	2864275 Germany
br	45139623	45815659	676036	1353	312927 Brazil
it	26905683	26969405	63722	40373	799928 Italy
cn	20321673	23167385	2845712	6642	18542 China
mx	18750674	20315274	1564600	1962	119526 Mexico
fr	18543657	18668024	124367	38836	665834 France
au	15354163	15538975	184812	71	97830 Australia
ar	15005067	15240889	235822	44	14395 Argentina
nl	14438234	14690554	252320	69702	3469774 Netherlands
ca	14034141	14275493	77653	105306	3803104 Russian Federation
pl	13306647	13598915	93188	2459	232478 Poland
edu	12031464	12413800	398336	9600	3770540 Educational
ca	9474798	9854173	379375	39083	1184881 Canada
in	7072841	71422219	69278	10851	88233 India
tr	7065064	7096457	31393	29	86989 Turkey
tw	6792367	6854017	61650	1450	28099 Taiwan
co	5897520	6211757	314237	7341	32411 Colombia
uk	5895058	6996769	1101711	776	123427 United Kingdom
se	5736012	5824251	88238	16845	440855 Sweden
be	5509538	5538027	28489	22011	163343 Belgium
ch	5188689	5304335	115646	29999	1359238 Switzerland
eg	5056160	5056107	1497	32	906 Egypt
es	4571926	4709646	137720	13749	543847 Spain
fi	4524785	4552467	27682	14991	2016258 Finland
za	4317684	4437713	120028	57	23865 South Africa
pt	4090941	4106697	15756	7720	309290 Portugal
no	3876632	3910825	34193	14757	304588 Norway
th	3788404	37788404	13670	17	4802 Thailand
at	3784477	3798474	3567	27517	37474 Austria
cz	3681507	3721414	39907	31070	1094135 Czech Republic
arpa	3649309	4802630	1153322	20	48039 Mistakes
hu	3400157	3414102	13945	17265	685023 Hungary
cl	3367633	3456218	88585	10945	65857 Chile
gr	3283920	3291037	7117	9139	95516 Greece
nz	3124604	3165404	40800	141	22860 New Zealand
ro	2805157	2999062	193905	25847	2067043 Romania
mil	2721590	27277275	2555685	189	175645 US Military
ua	2526160	2711942	185774	2370	133607 Ukraine
il	2508541	2555551	47010	20	11668 Israel
dk	2443768	2480837	37063	17154	127605 Denmark
gov	2335894	3317628	981734	2209	671557 Government
org	2292168	2501479	209311	270632	1515115 Organizations
us	2043997	2168284	124287	24055	93188 United States
id	1923872	1967850	43978	134	7811 Indonesia
uy	1796848	1801088	4240	59	1802 Uruguay
ie	1542612	1555389	10477	9081	252967 Ireland
ve	1520010	156674	12474	32	1040 Venezuela
sg	1444363	2128855	68432	1086	10464 Singapore
unknown	1380080	14291824	12901744	311307	491684 Unknown
lt	1389144	1392697	3553	5329	438752 Lithuania

Top-level Domains (TLDs) Overview

For the day of **January 6, 2016**

TLD	New	Deleted	Transferred	Current Total
.COM	123,499	92,108	139,868	123,909,111
.NET	11,687	11,046	15,362	15,748,102
.ORG	7,449	6,785	8,106	10,945,980
.INFO	4,362	4,042	2,885	5,220,012
.BIZ	1,330	1,997	1,965	2,413,101
.US	1,112	956	814	1,736,235
TOTALS	149,439	116,934	169,000	159,972,541

Above shows 123 million .com sites out
Of a total 149 million; see
<http://www.dailychanges.com>

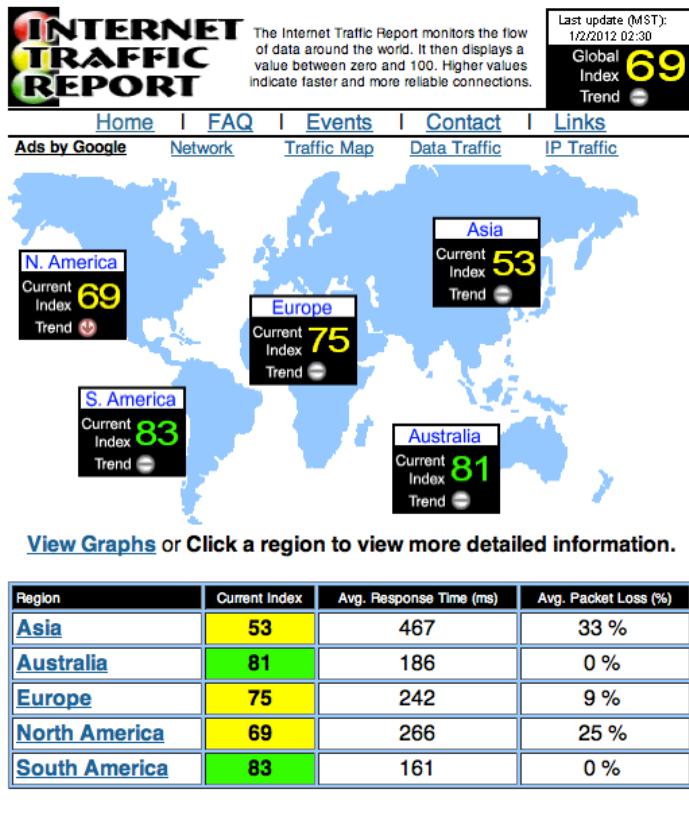
Try also:

<http://research.domaintools.com/statistics/tld-counts/>

Conclusion: the .net and .com categories are the largest followed by Japan, Brazil and Germany

Internet Traffic

- How efficiently is the Internet working now
 - <http://www.internettrafficreport.com/>
 - <http://www.internet2.edu/>



internet2 is a project to develop new technologies for high-performance computer networking. It is led by a consortium of 206 universities. While specifically developed to facilitate research and educational purposes, the involvement of research, commercial and government organizations also aims to distribute these technology into the wider community. The tables below is the latest available and it shows the type and amount of traffic

The screenshot shows a browser window displaying a NetFlow report for the week of 20100426. The URL is <http://netflow.internet2.edu/weekly/20100426/>. The report table is titled "Table 6. Aggregated Application Types (Full Data Set)".

Type	Octets	Packets
Data Transfers	39.08% 713.6T	41.40% 1,002T
Encrypted Traffic	5.25% 95.8T	5.94% 143.7G
Measurement	2.76% 50.30T	2.23% 53.90G
File Sharing	1.96% 35.71T	1.56% 37.69G
Advanced Apps	1.73% 31.54T	1.48% 35.73G
Misc	1.65% 30.08T	3.46% 83.82G
Audio/Video	0.52% 9.46T	0.43% 10.29G
Games	0.23% 4.24T	0.38% 9.141G
Unidentified	46.83% 855.1T	43.14% 1,045T
Total	100.00% 1.825P	100.00% 2.422T

This table is available additionally in the following more verbose version (no applications are aggregated into classes, but class composition is shown):

Traffic type	Octets	Packets
Data Transfers	---	---
HTTP	37.24%	679.9T
HTTPS	0.93%	17.05T
Rsync	0.73%	13.30T
FTP	0.73%	0.53% 12.78G
NNTP	0.18%	3.304T
Encrypted Traffic	---	---
HTTPs	2.63%	48.02T
SSH	2.33%	42.55T
IPsec ESP	0.28%	5.131T
IPsec AH	0.00%	83.91G
IPsec IKE	0.00%	16.98G

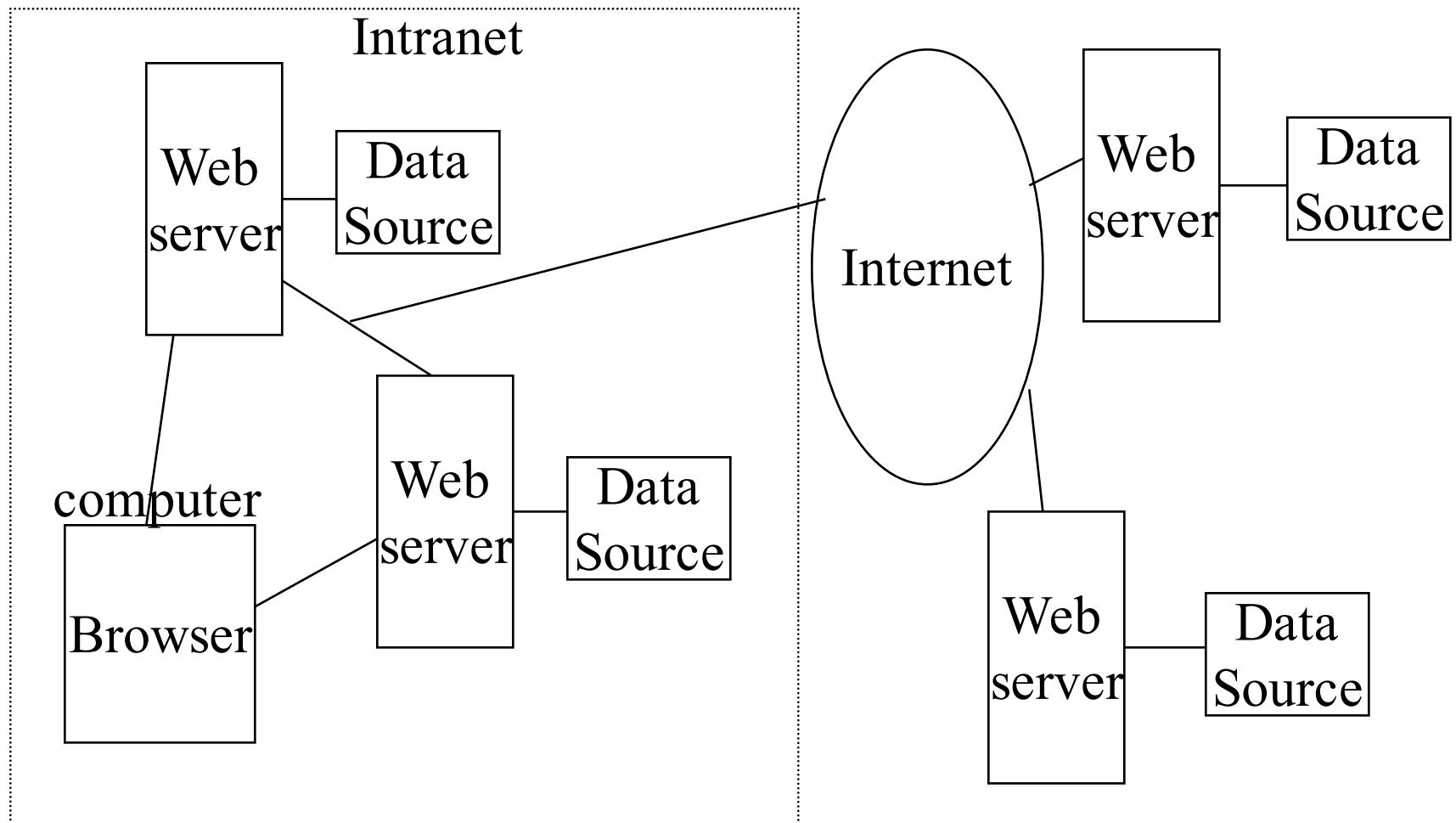
In April 2010:
Data Transfers was 41%

HTTP was approx 39%
HTTPS was approx 48% of
encrypted traffic

Defining the World Wide Web

- A wide-area hypertext, multimedia information retrieval system that provides access to a large universe of documents
- A uniform way of accessing and viewing some information on the Internet
- The WWW
 - creates a world in which information has a reference by which it can be accessed
 - subsumes the capabilities of ftp, gopher, wais and news

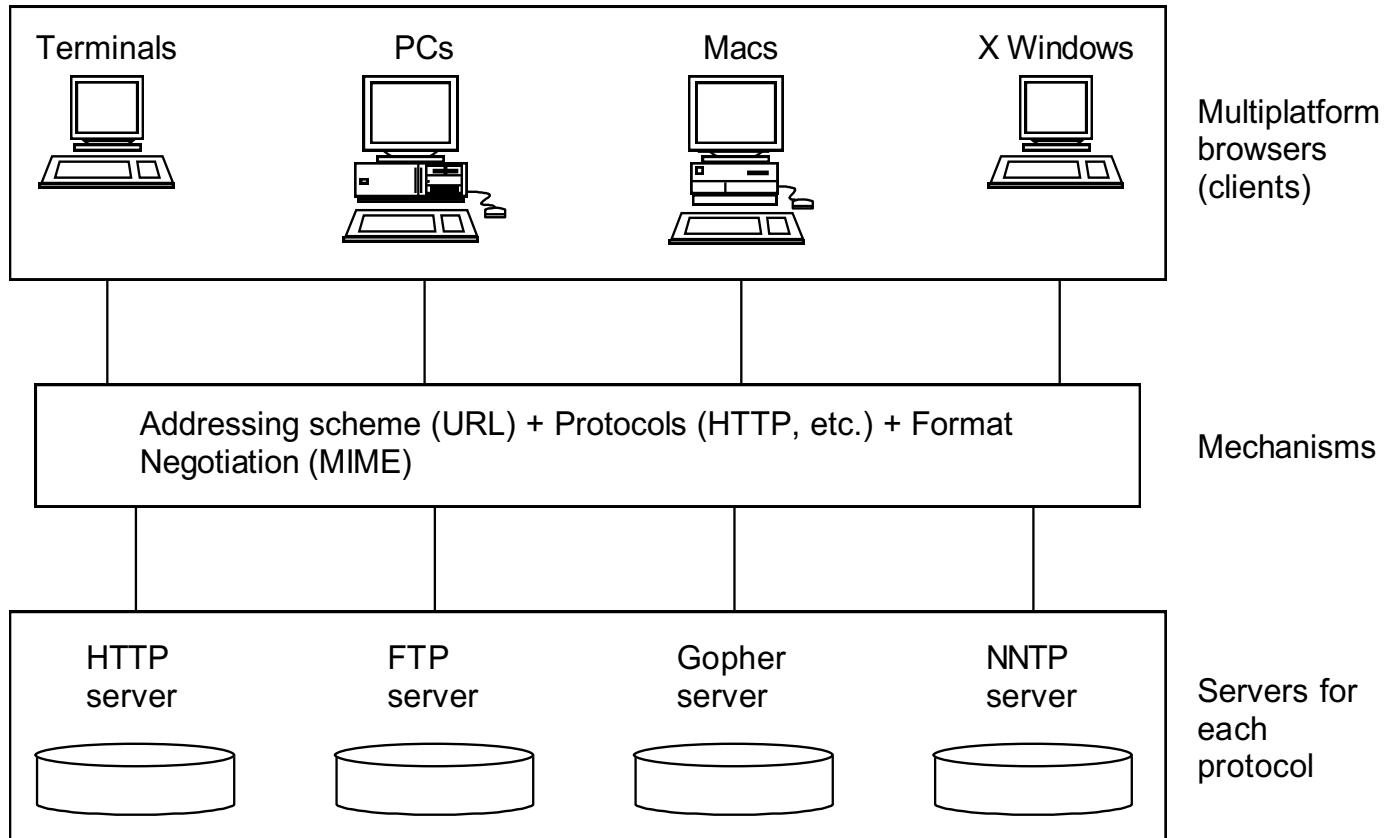
Graphical View of the WWW



Major Technology Components

- **Client/server architecture**
 - where client programs interact with web servers
- **Network protocol**
 - HTTP, Hypertext Transfer Protocol, is the language understood by browsers and web servers
 - designed to move quickly from document to document
- **Addressing system** (Uniform Resource Locators)
 - `http://domain/directory/file.html`
- **Markup Language**
 - every web server understands and every browser displays
 - includes support for HyperText and multimedia

Client/Server Architecture Model



The WWW Server

- Web browsers and Web servers communicate according to a protocol known as HTTP (HyperText Transfer Protocol)
 - The current HTTP protocol is version 1.1
- The Web server is a software system running on a machine often called the Web server, don't confuse them
- A web server can
 - receive and reply to HTTP requests
 - retrieve documents from specified directories
 - run programs in specified directories
 - handle limited forms of security
- A web server does not
 - know about the contents of a document, links in a document, images in a document or whether a particular file, e.g. a *.gif file, is in the correct format

Uniform Resource Locator (URL)

- A mechanism whereby an Internet resource can be specified in a single line of ASCII text
- See RFC 1738: <http://www.faqs.org/rfcs/rfc1738.html>

URL

Refers to:

`file://pub/xt.ps`

a PostScript file in directory
pub on your local machine

`ftp://usc.edu/docs/sweng.txt`

file sweng.txt in directory docs
on usc.edu, an anonymous ftp site

`http://nunki.usc.edu/mydocs/book.doc`

a file in directory mydocs on
machine nunki.usc.edu, a WWW site

`news:comp.compilers`

the newsgroup computers.compilers

`mailto:horowitz@usc.edu` an e-mail address

General Description of a URL

1. Scheme followed by a colon
http:, ftp:, gopher:, news:, mailto:, wais:, telnet:
2. Double slash (only for http, ftp, gopher, wais) //
3. Internet domain name e.g., pollux.usc.edu
4. Port number (this field is optional; e.g., pollux.usc.edu:8081)

Standard or default port numbers:

---	ftp is 21	gopher is 70
---	telnet is 23	http is 80
---	smtp is 25	nntp is 119
---	imap is 143	secure nntp is 563
---	pop3 is 110	secure pop3 is 995

5. Path e.g., /pub/docs

URL Character Set

- RFC 1738, Dec. 1994 defines the URL character set as
"...Only alphanumerics [0-9a-zA-Z], the special characters "\$-
.+'(),," **[not including the quotes]**, and reserved characters used
for their reserved purposes may be used unencoded within a URL."
- However, HTML supports ISO-8859-1 (ISO-Latin) character set
 - HTML 4.x extends the character set to all of Unicode
- Therefore, in URLs an escape mechanism is used, % followed by two hex digits
- Characters that should be encoded include:
%, /, ., .., #, ?, :, \$, +, @, &, =
- Here are some encoded values for so-called “unsafe” characters

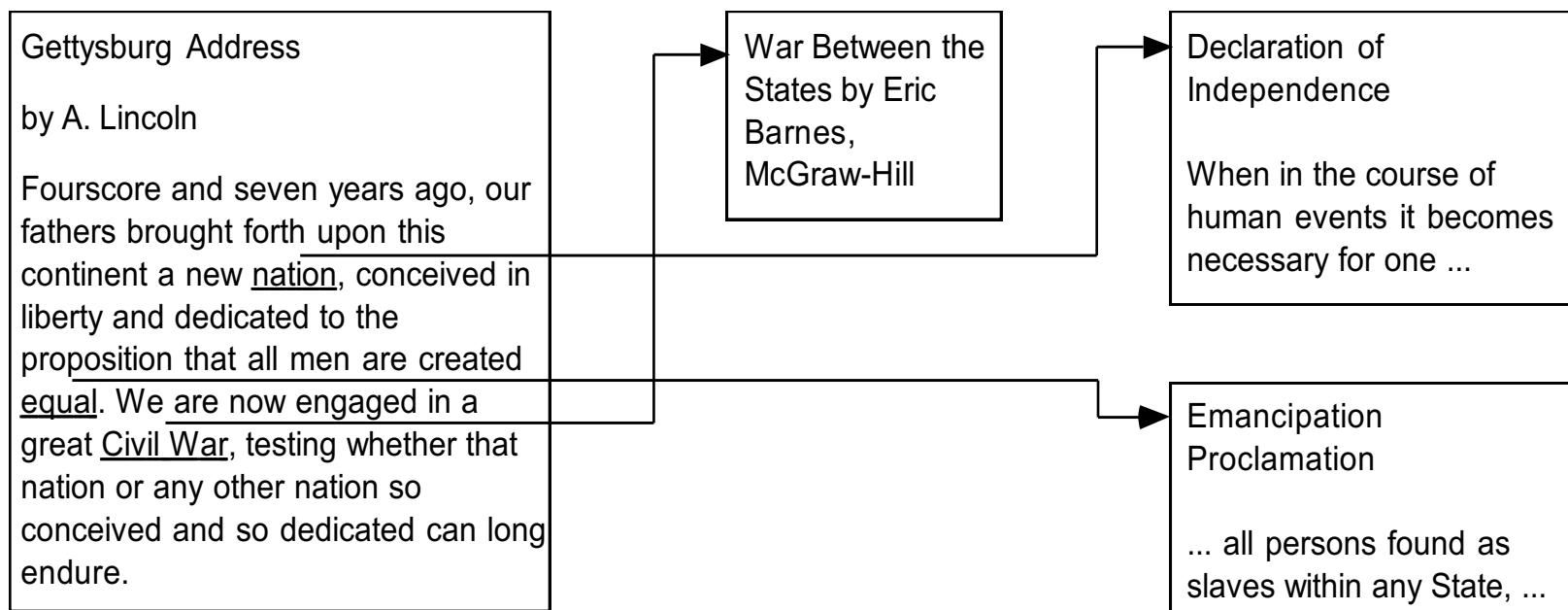
~	%7E		%7C
SPACE	%20	\	%5C
%	%25	^	%5E
&	%26	[%5B
=	%3D]	%5D
?	%3F	#	%23
{	%7B	>	%3E
}	%7D	<	%3C

Markup Languages

- HTML - hypertext markup language, specifies document layout and the specification of hypertext links to text, graphics and other types of objects
- Browsers display text and graphics using the markup as guidance
- However, HTML is *not* like a word processing program, e.g. Microsoft Word or WordPerfect, and *not* like a page description languages, e.g. postscript
 - as a result, translation into HTML can produce a result that does not look exactly like the original

What is HyperText?

- Regular text, with the additional feature of links to related documents
- As you read documents and follow links, you traverse a “web” of interconnections

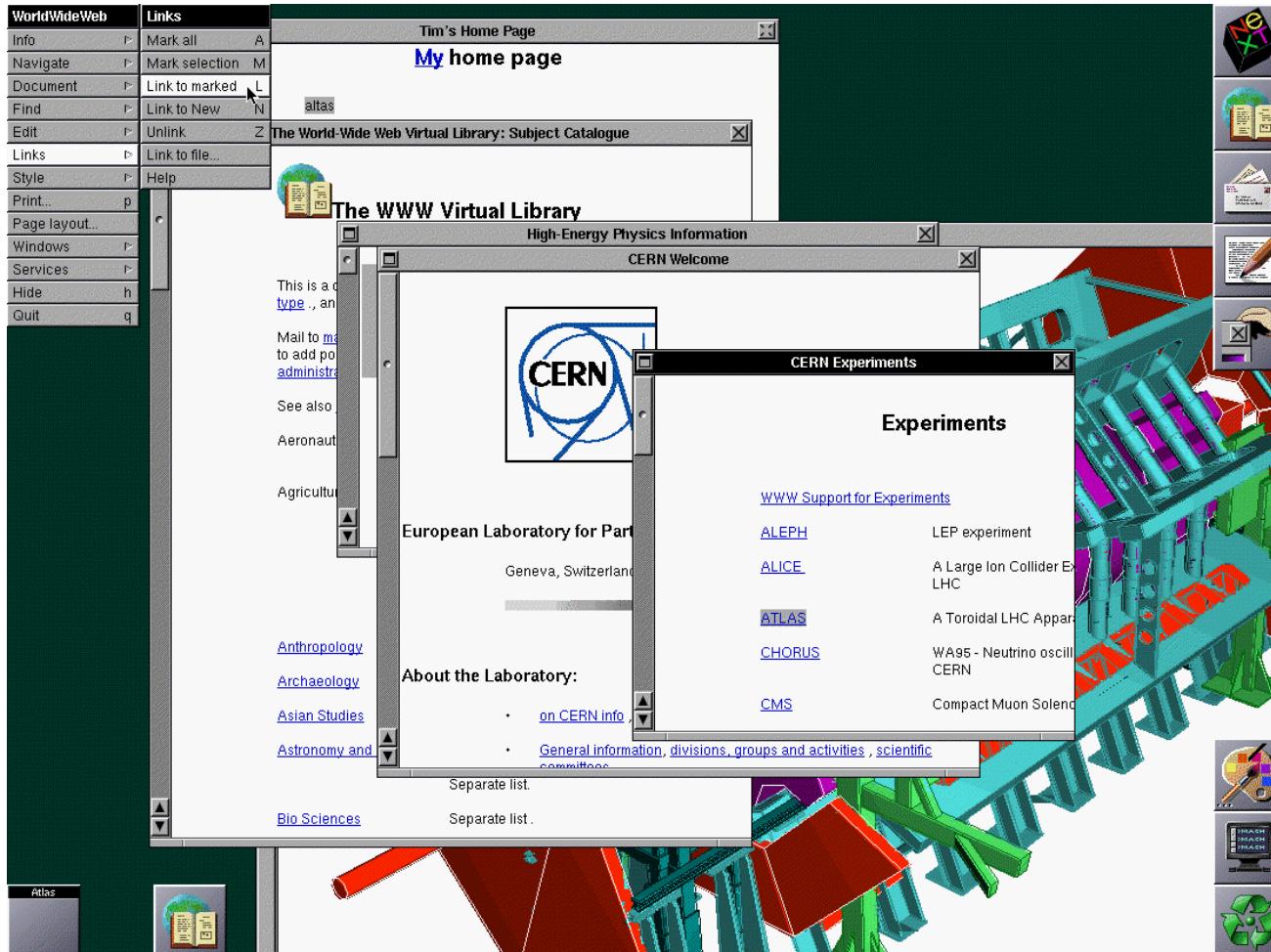


Early History of the WWW

- 1989-1990 Tim Berners-Lee conceives the WWW at CERN in Geneva
- 1990 Berners-Lee releases WWW prototype on NeXT computer
- 1992 Release of source code for line mode browser,
lynx and HTTP
- 1993 Mosaic browser from NCSA is released
- 1993 WWW internet traffic now measures 1% of NSF backbone
- 12/94 Netscape Navigator 1.0 is released
World Wide Web Consortium formed
- 1995 Microsoft Windows 95 and Internet Explorer 1.0 released
- 1995 Java is released
- 1998 Google is started
- 1999-2001 A burst of Internet start-up companies which flamed out because they were not profitable
- 2004 Firefox 1.0 is released
- 2005 YouTube is founded
- 2008 Google Chrome 1.0 is released

First Web Communication (Dec 1990)

See <http://www.w3.org/History.html> and tim Berners-Lee's presentation at the 10th anniversary, <http://www.w3.org/2004/Talks/w3c10-HowItAllStarted/?n=1>



WWW Consortium

- Founded in 1994, headed by Tim Berners-Lee,
<http://www.w3.org>
- Goal: “to lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability.”
- Many of the technologies guided by the WWW consortium will be discussed this semester:
 - HTML, Style Sheets, Document Object Model, international character sets, HTTP, XML, etc.