

Lecture

Internet Trends and Web Basics

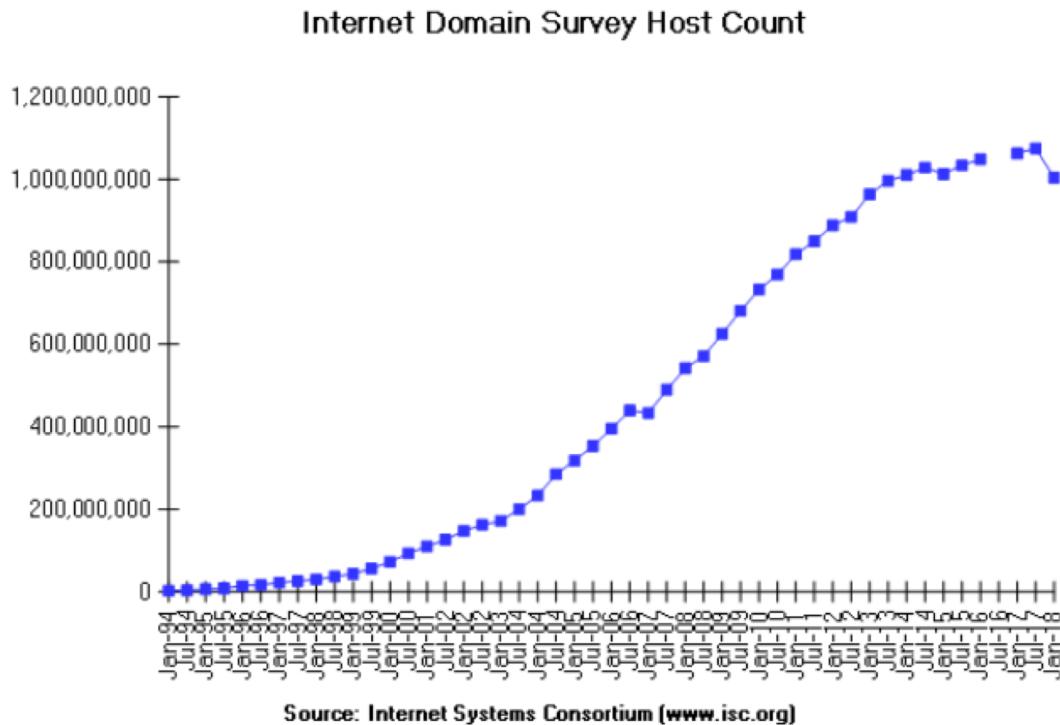
The Internet and the WWW are Different

- 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
- Growth in use of the cloud

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 18	1,1015,787,389
Jan 18	1,0003,604,363
Jul 17	1,074,971,748
Jan 17	1,062,660,523
Jan 16	1,048,766,623
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	



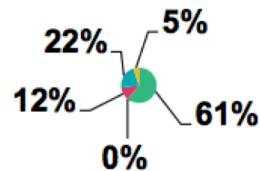
Source: United Nations / International Telecommunications Union, US Census Bureau. Internet user data is as of mid-year. Internet user data for: China from CNNIC, India from IAMAI, Iran from Islamic Republic News Agency, citing data released by the National Internet Development Center, Indonesia from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

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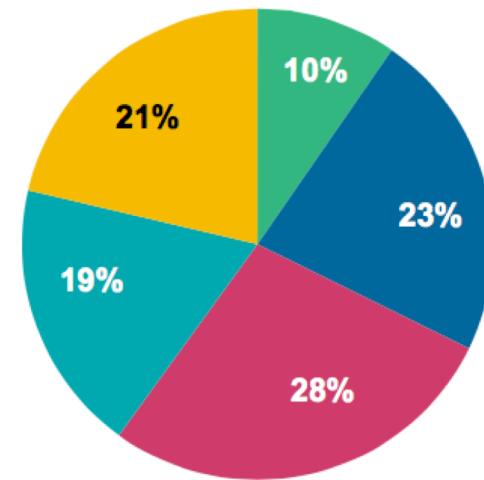
The following slides are based upon a presentation by Mary Meeker of Kleiner Perkins Caufield and Byers, see <http://www.kpcb.com/insights/2014-internet-trends> and <http://www.kpcb.com/insights/2015-internet-trends>, <http://www.kpcb.com/internet-trends>

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

1995
35MM+ Internet Users
0.6% Population Penetration

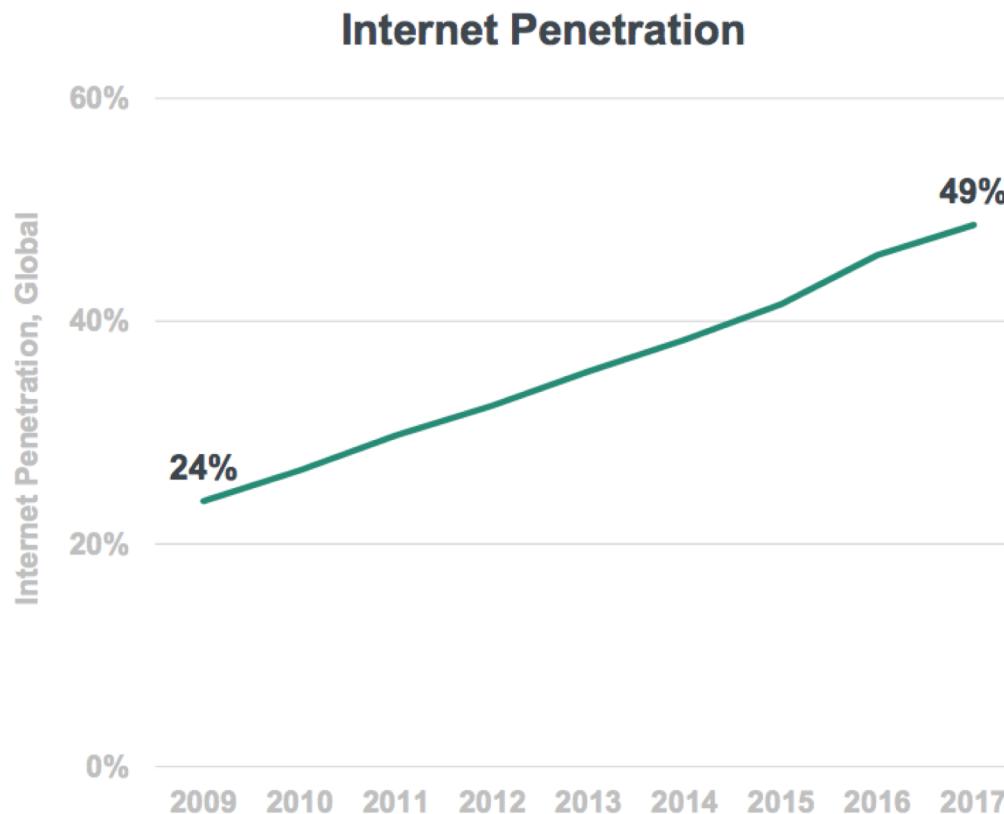


2014
2.8B Internet Users
39% Population Penetration

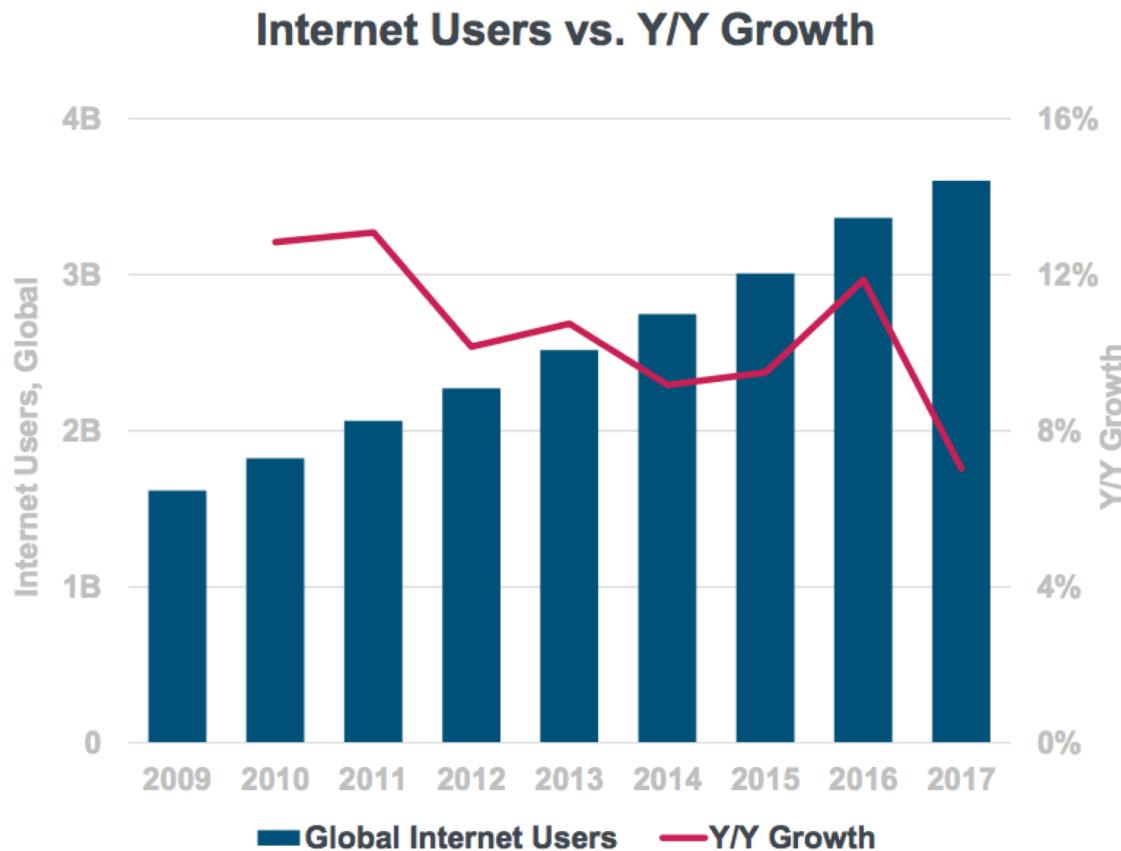


■ USA ■ China ■ Asia (ex. China) ■ Europe ■ Rest of World

**Global Internet Users =
3.6B @ >50% of Population (2018)**

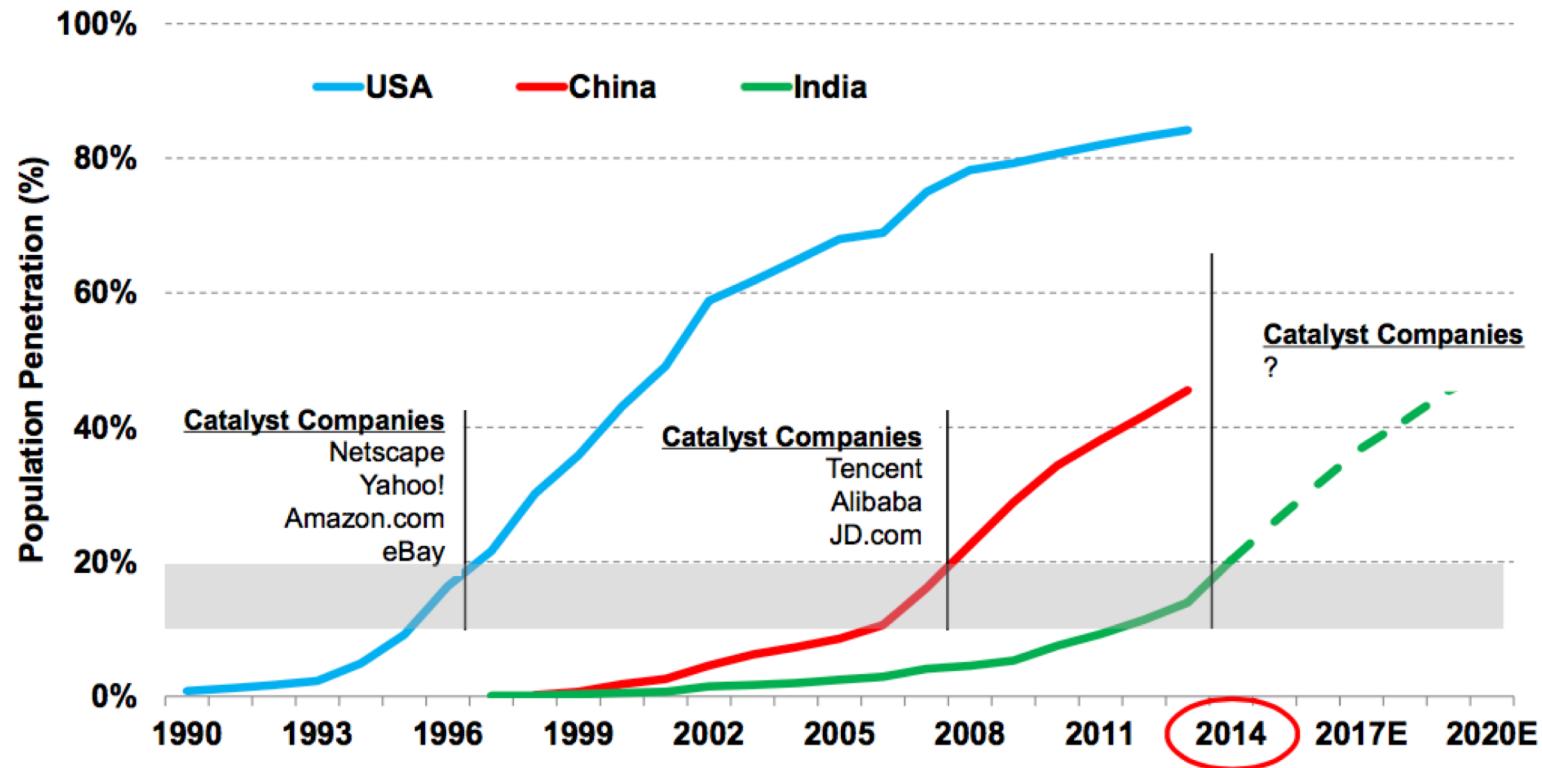


Global Internet Users = Slowing Growth @ +7% vs. +12% Y/Y



India = Appears to Be @ Internet Penetration Growth Inflection

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



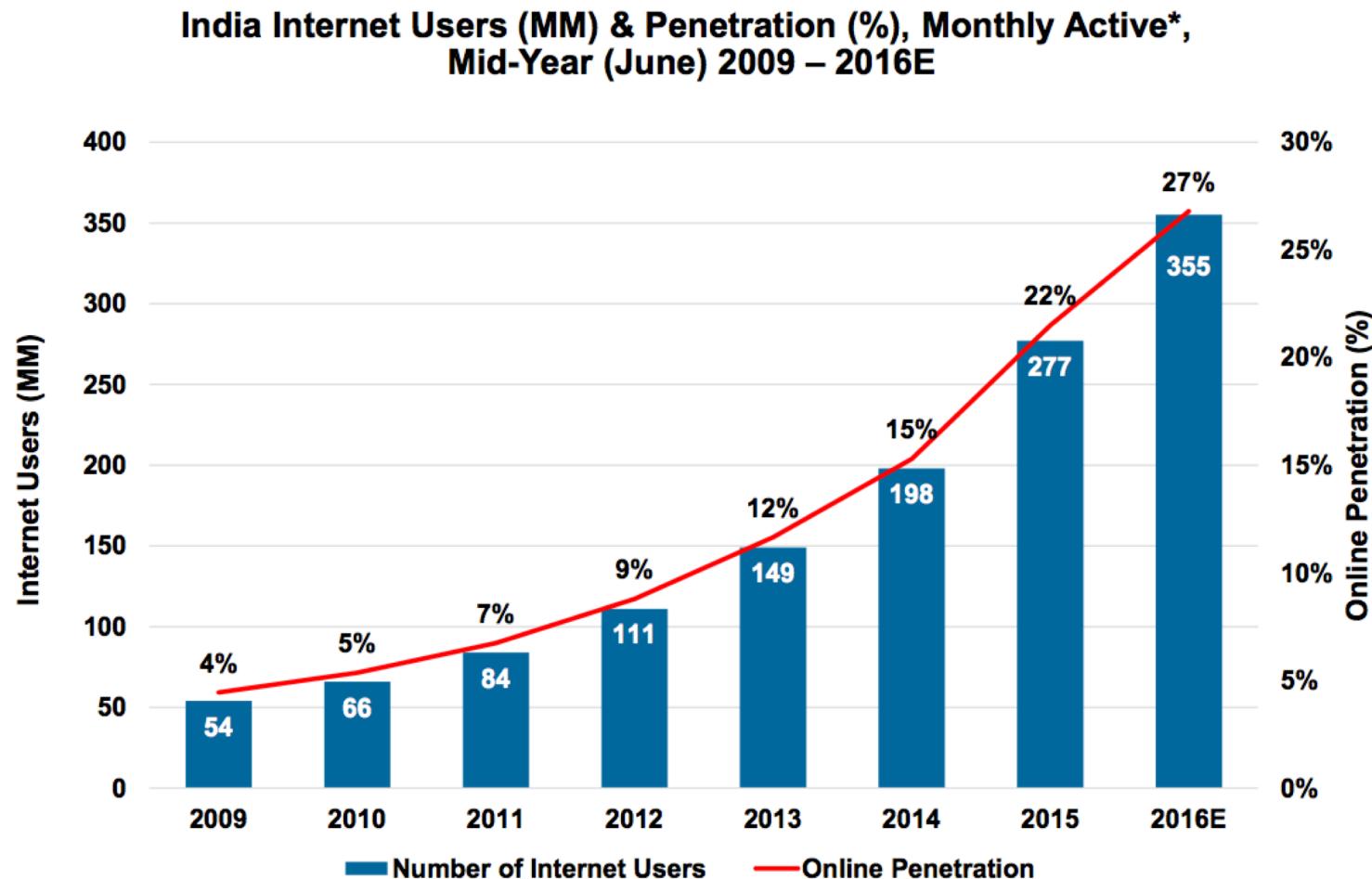
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Source: World Bank, Hillhouse Capital forecast for India beyond 2014.

Hillhouse Capital

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India Internet Users = +28% (2016-June) vs. 40% Y/Y Growth
 @ 27% Penetration 355MM Users #2 Behind China



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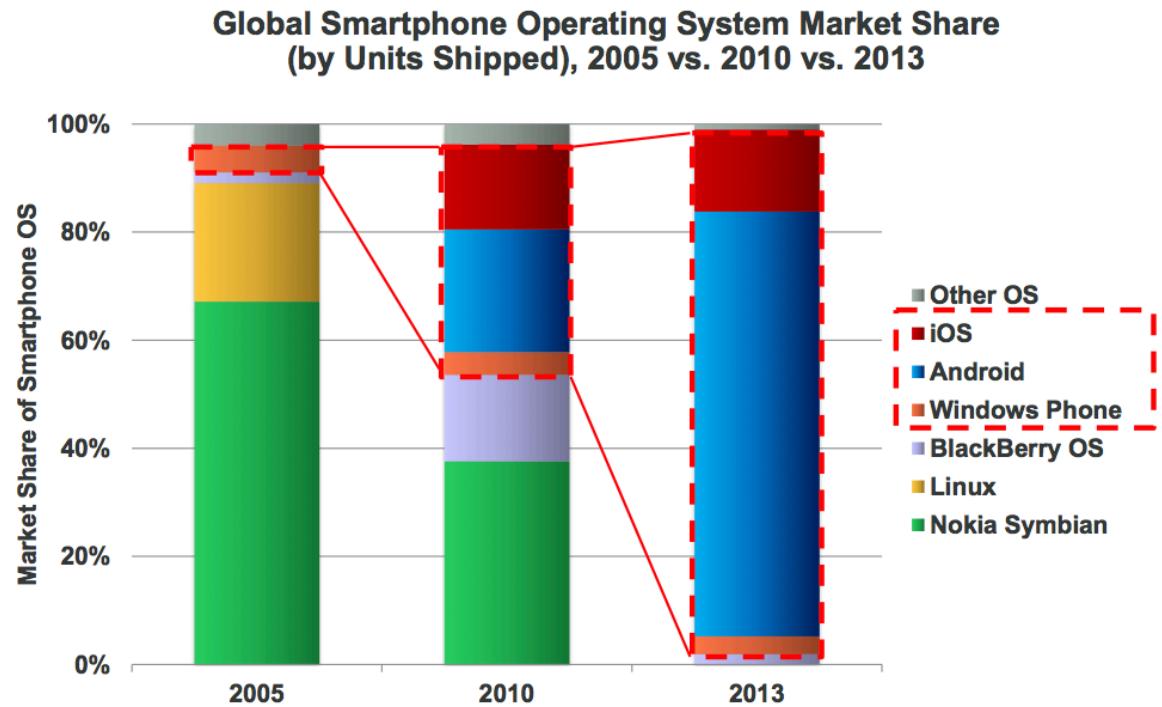
Source: IAMAI, UN Population Division, Worldometer, KPCB estimates based on IAMAI data. Uses mid-year figures.

*Note that "Monthly Active Users" are distinct from "Ever" users, which IAMAI defines as anyone who has ever accessed the internet. Owing to increasing activity levels, the number of "Monthly Active Users" may grow faster than "Ever" users.

KP INTERNET TRENDS 2017 | PAGE 234

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

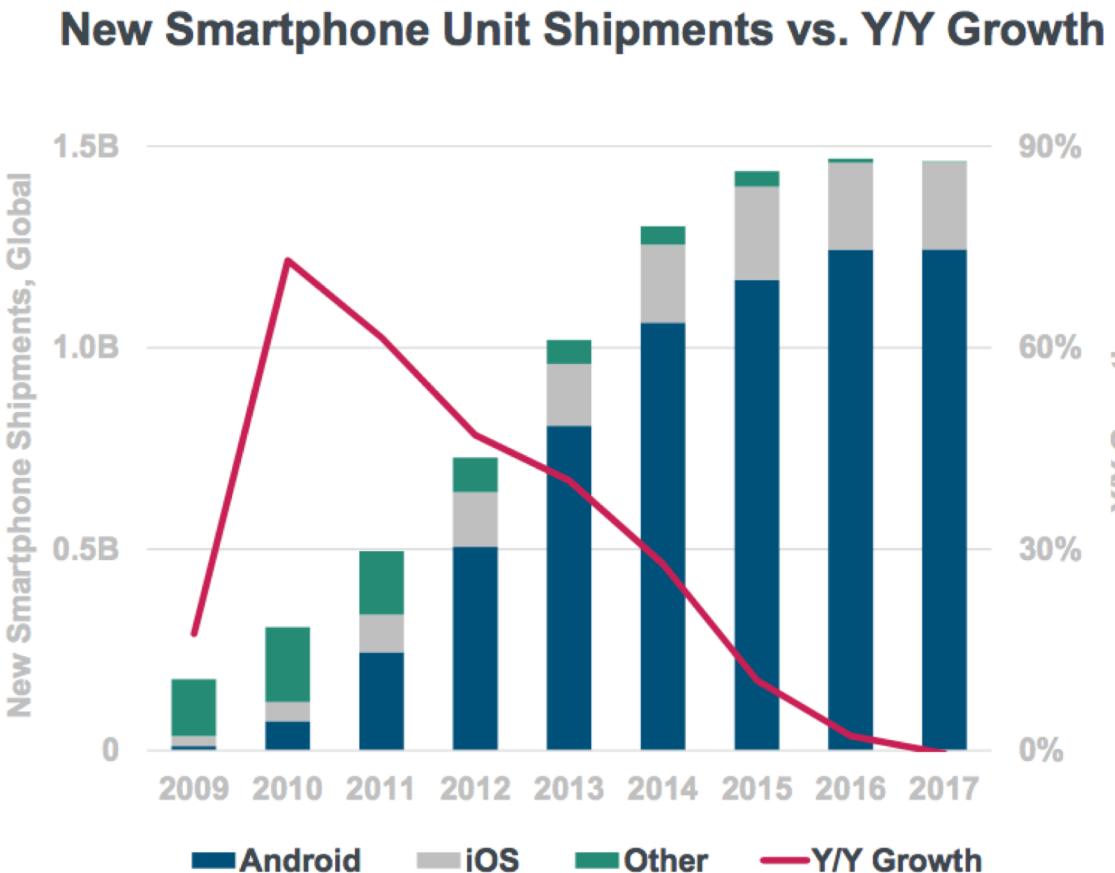


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Source: 2005 & 2010 data per Gartner, 2013 data per IDC.

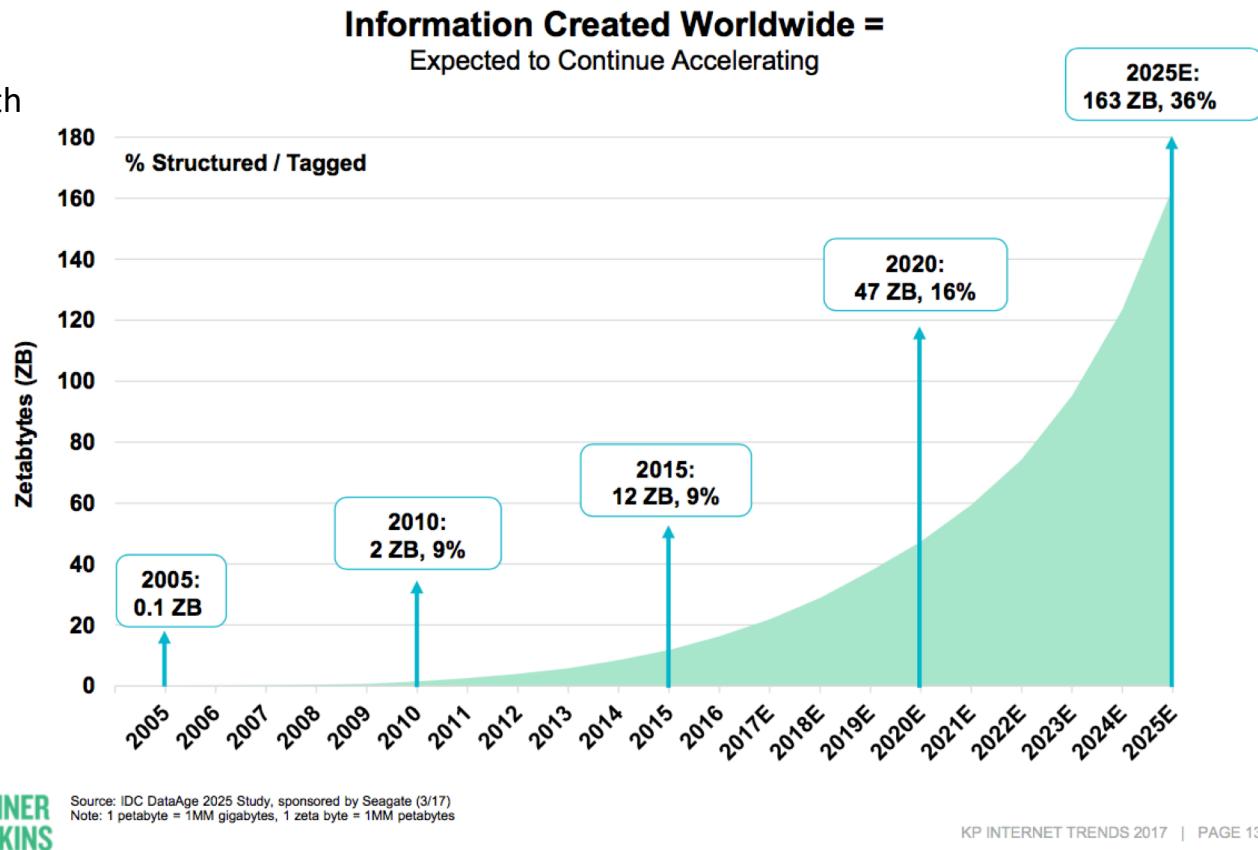
10

Global New Smartphone Unit Shipments = No Growth @ 0% vs. +2% Y/Y



Data Volume Growth Continues @ Rapid Clip % Structured / Tagged (~10%) Rising Fast

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

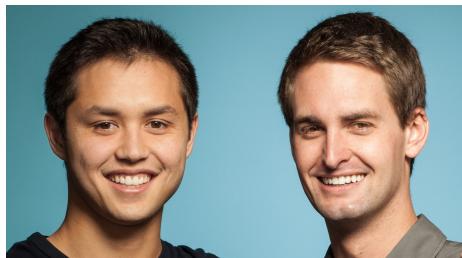


Photos Alone = 1.8B+ Uploaded & Shared Per Day... Growth Remains Robust as New Real-Time Platforms Emerge

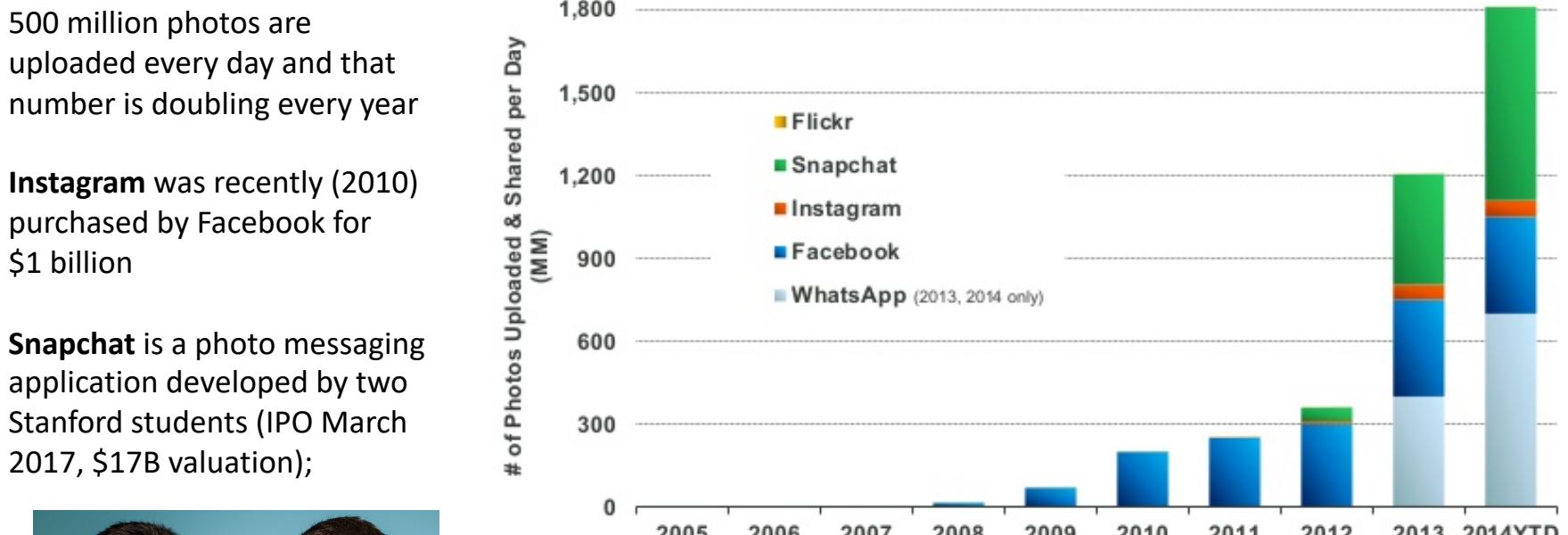
500 million photos are uploaded every day and that number is doubling every year

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

Snapchat is a photo messaging application developed by two Stanford students (IPO March 2017, \$17B valuation);



bobby Murphy - Evan Spiegel



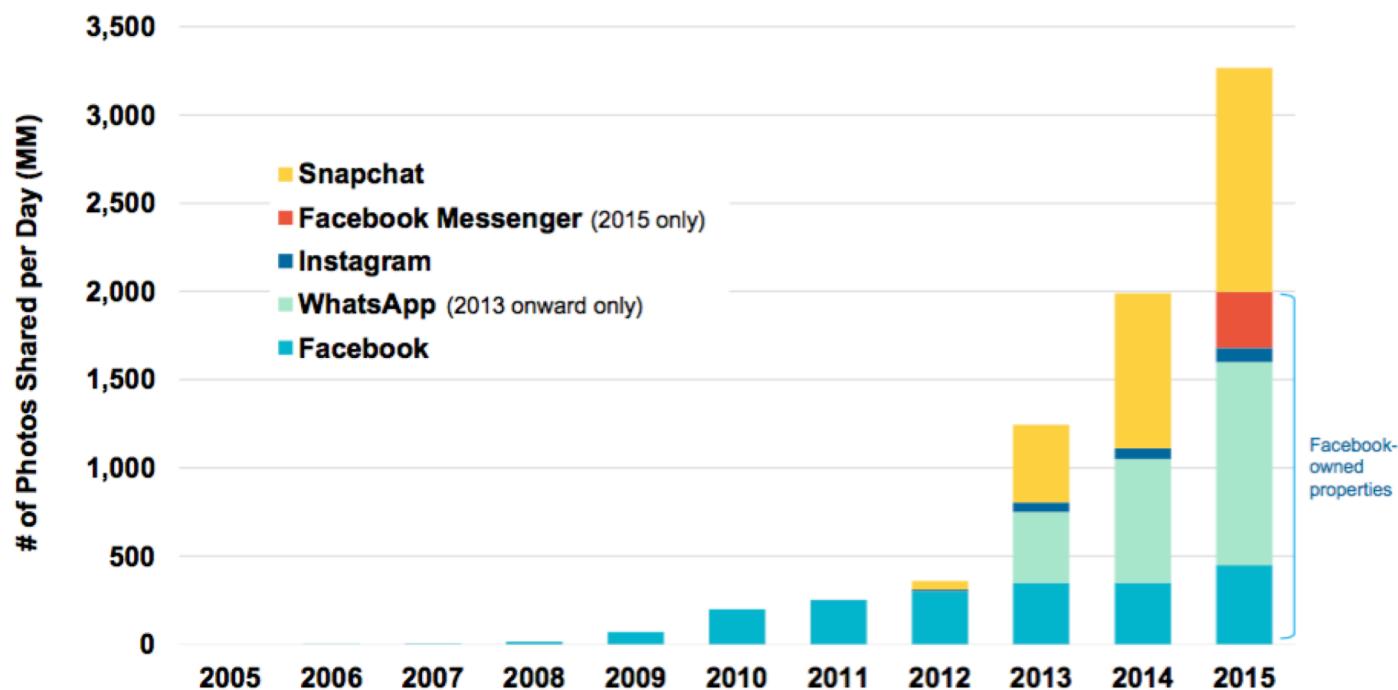
Source: KPCB estimates based on publicly disclosed company data. 2014 YTD data per latest as of 5/14.

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Image Growth Remains Strong

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



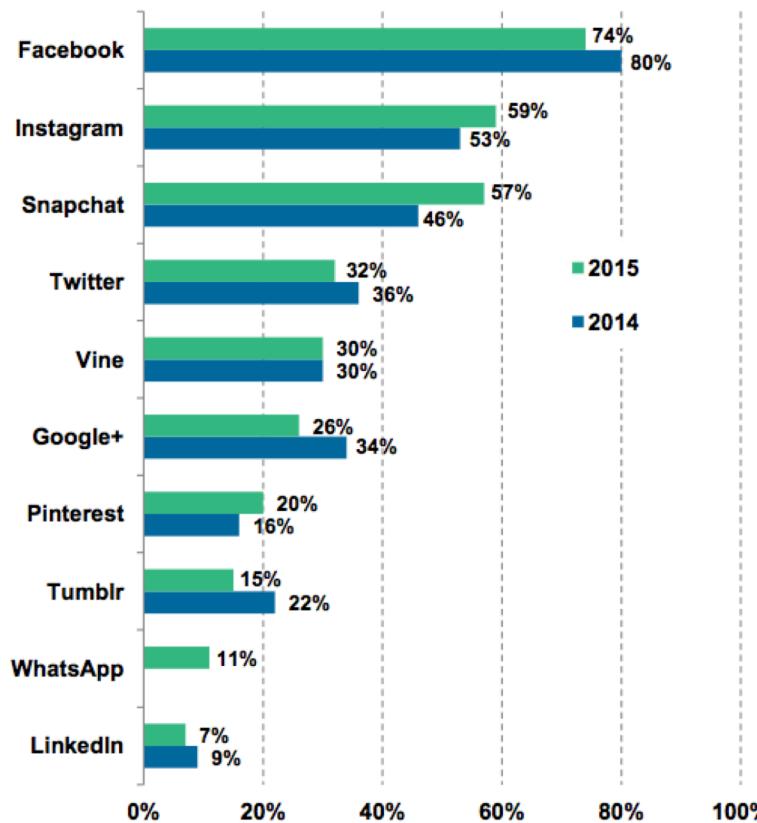
Source: Snapchat, Company disclosed information, KPCB estimates
Note: Snapchat data includes images and video. Snapchat stories are a compilation of images and video. WhatsApp data estimated based on average of photos shared disclosed in Q1 15 and Q1 16. Instagram data per Instagram press release. Messenger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

@KPCB

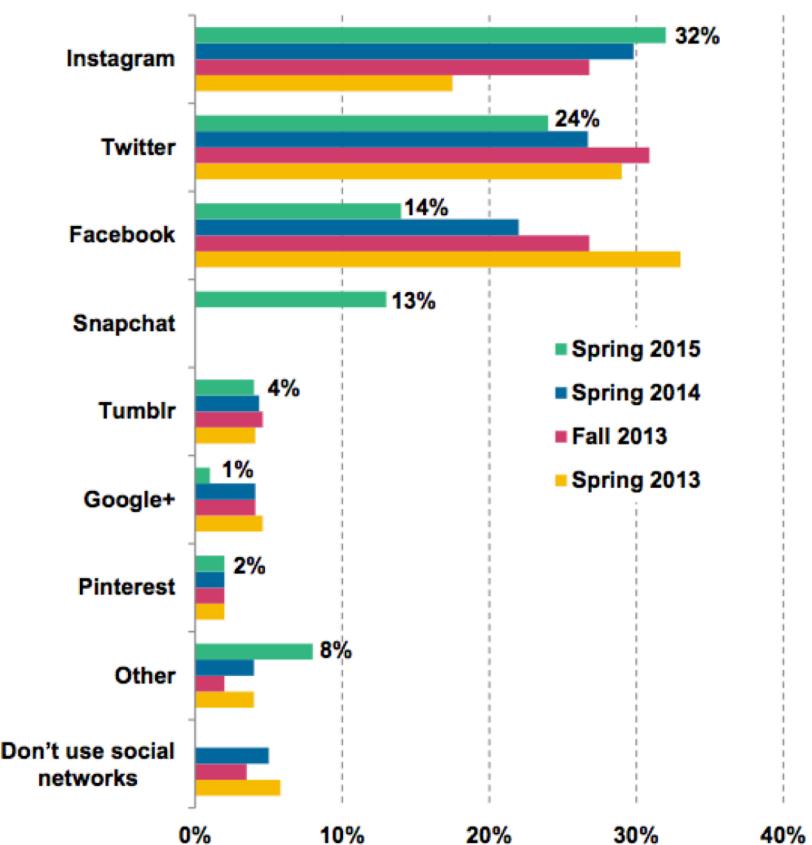
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12-24 Year Olds Internet Usage = Visual Stuff (In & Out) Rules... Instagram + Snapchat + Pinterest = Continue to Rise

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



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



@KPCB

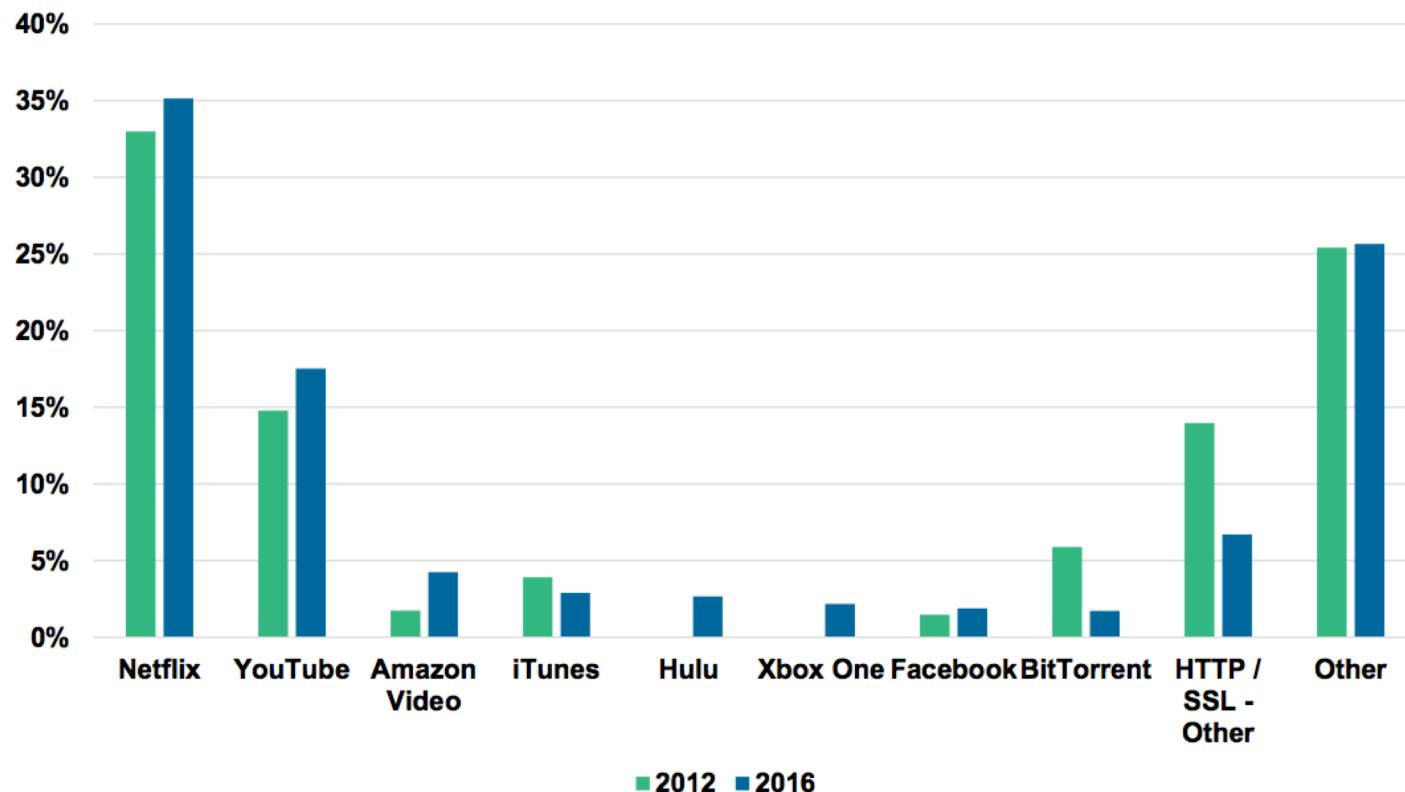
Source: Edison Research / Triton Digital, Piper Jaffray.

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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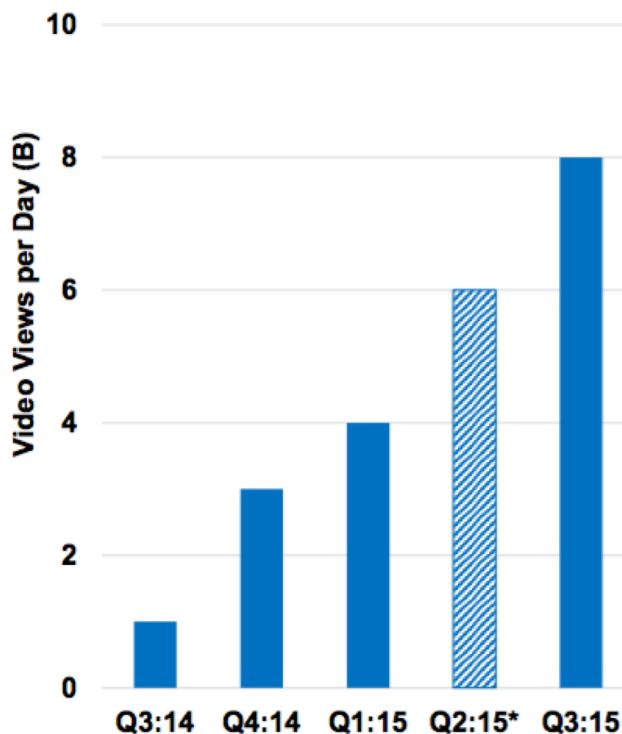
Netflix / YouTube = Fixed-Access Video Traffic Share Leaders

Share of Downstream Video Traffic (%), North America, 2H 2016

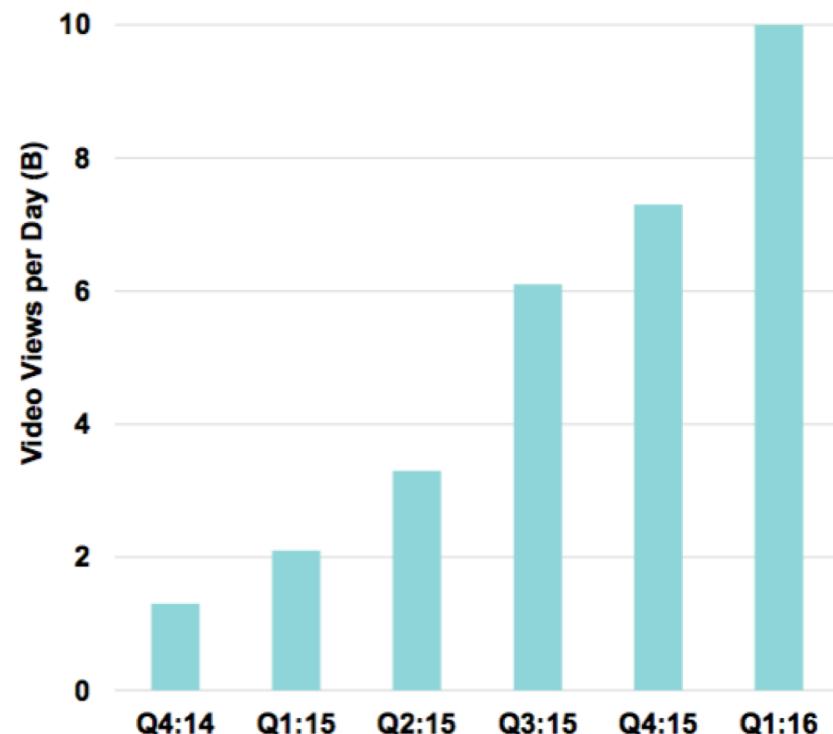


User-Shared Video Views on Snapchat & Facebook = Growing Fast

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



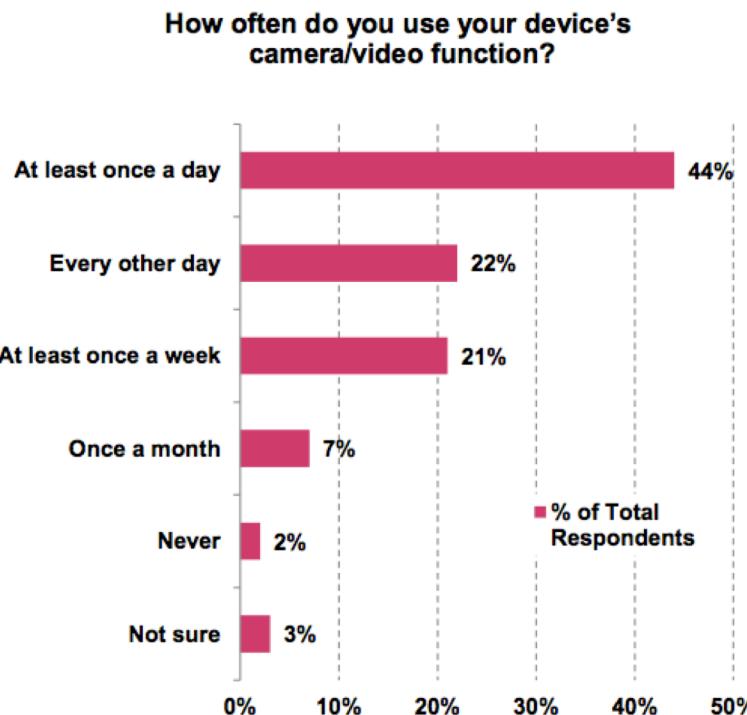
**Snapchat Daily Video Views,
Global, Q4:14 – Q1:16**



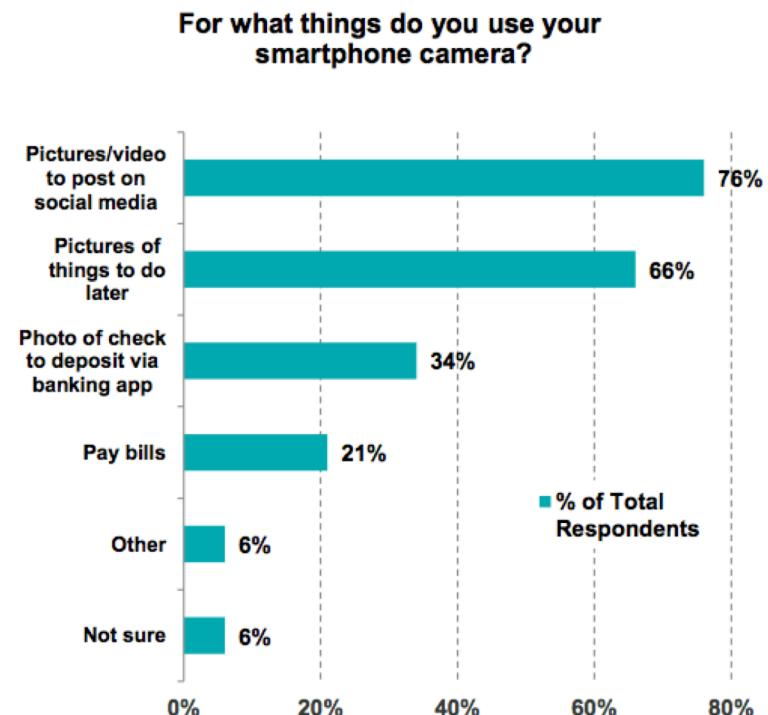
Millennials Love Their Smartphone Cameras...

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

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



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



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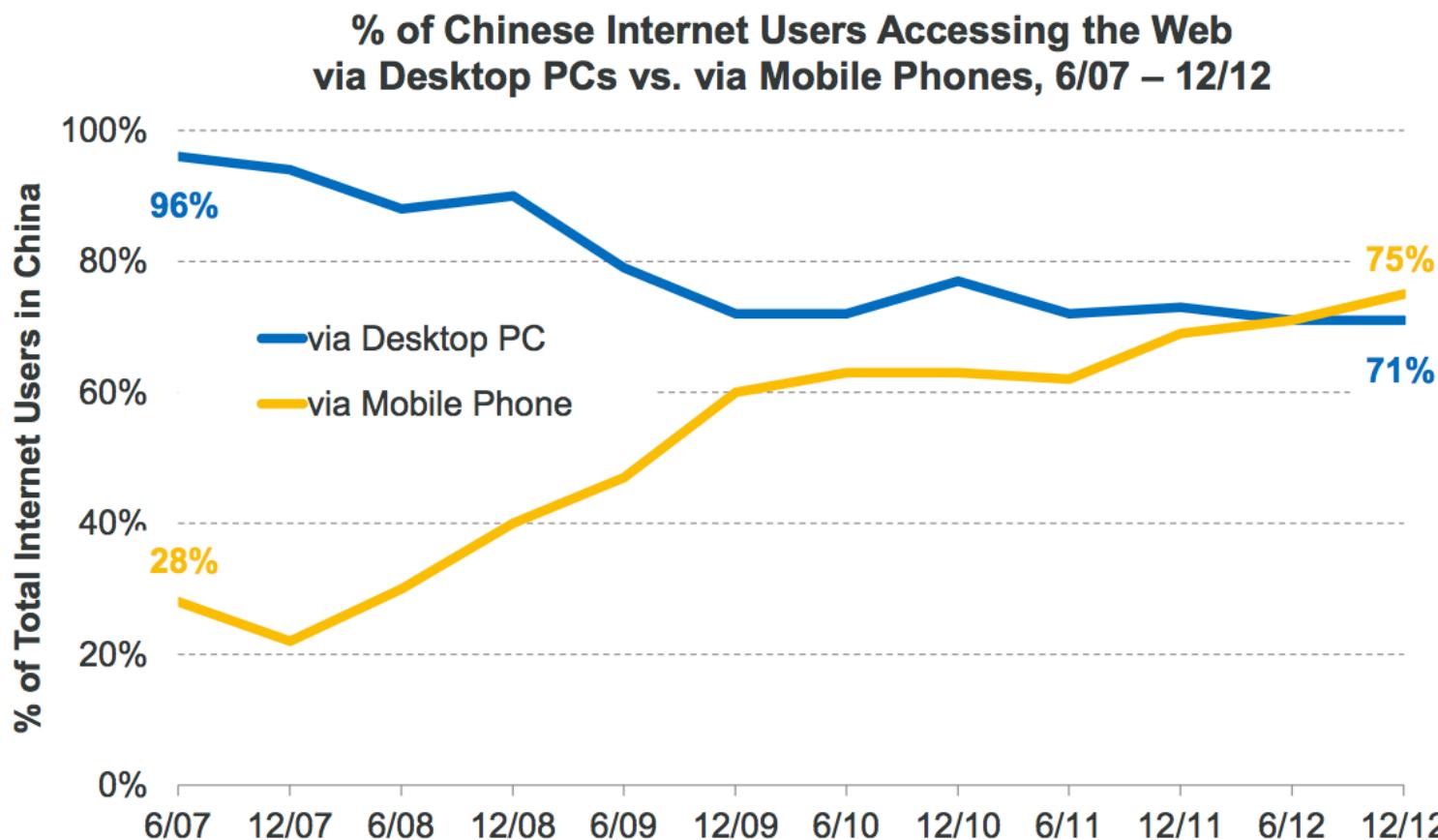
Source: Zogby Analytics.

*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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China – Mobile Internet Access Surpassed PC, Q2:12

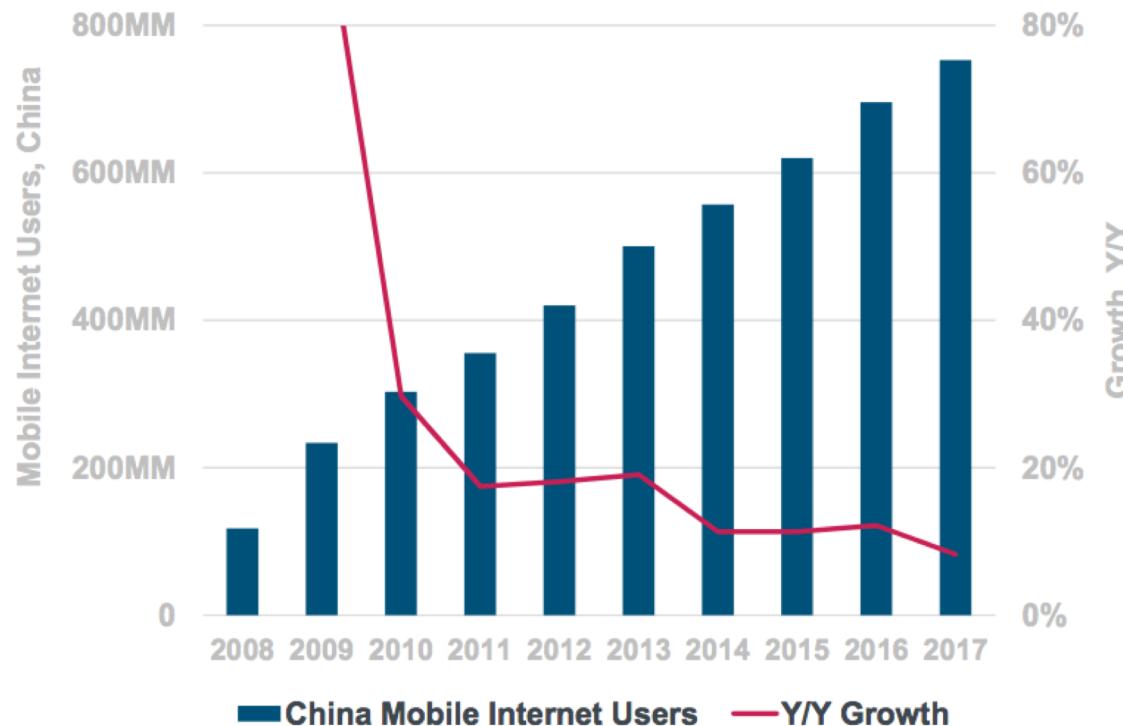


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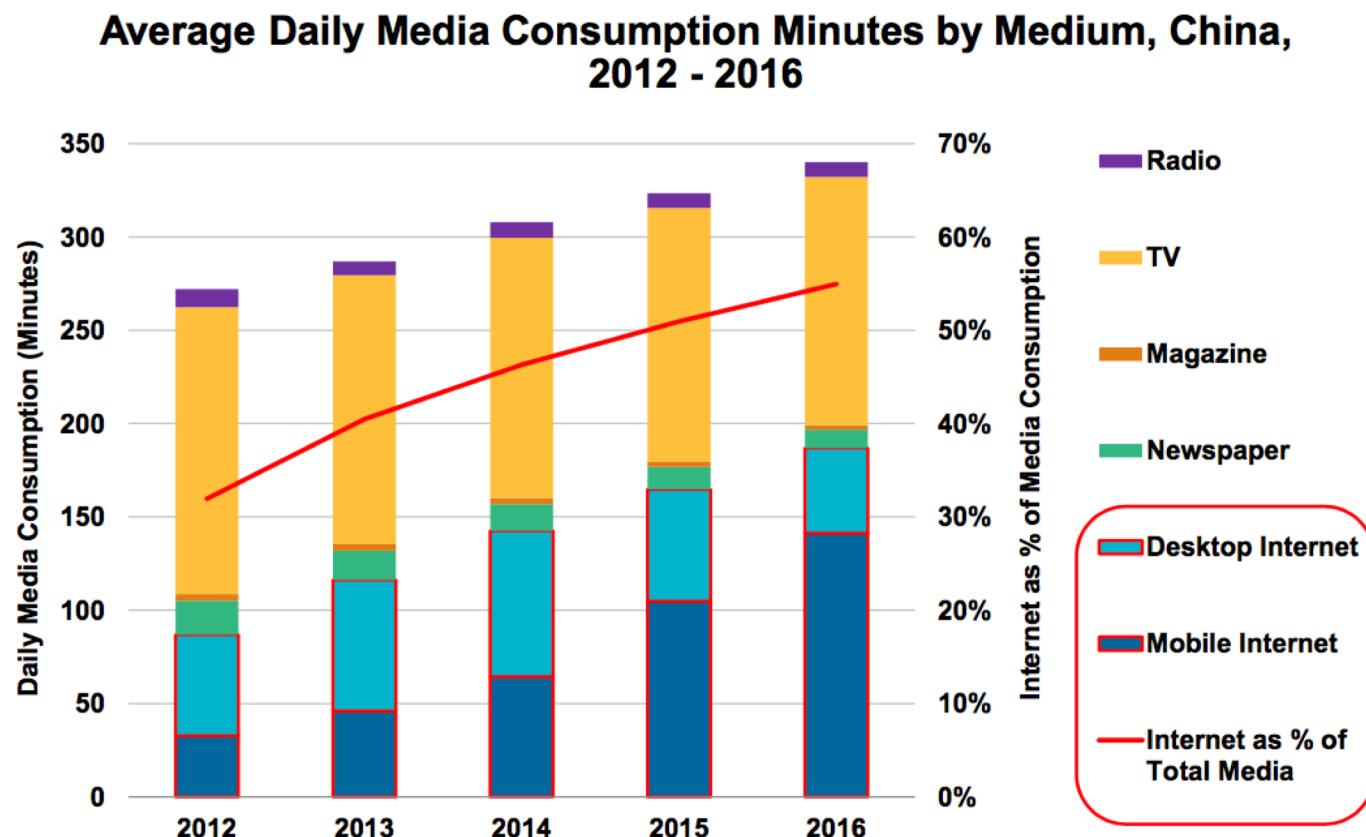
Source: CNNIC, 1/13. 33

**China Mobile Internet Users =
753MM...+8% vs. 12% Y/Y**

China Mobile Internet Users vs. Y/Y Growth



China Media = Internet @ 55% of Time Spent Mobile > TV (2016)



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Source: Zenith Optimedia

HILLHOUSE
Capital

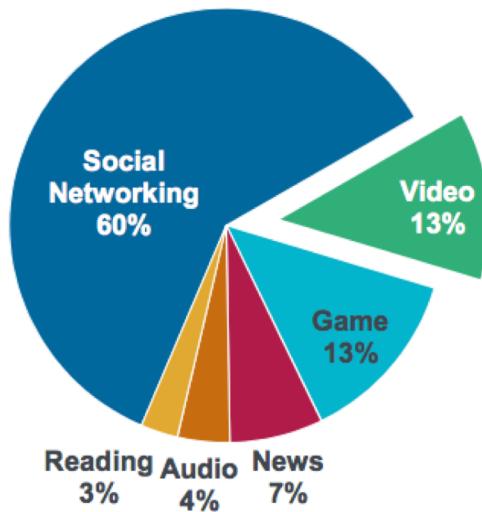
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China Mobile Media / Entertainment Time Spent = +22% Y/Y...Mobile Video Growing Fastest

China Mobile Media / Entertainment Daily Time Spent

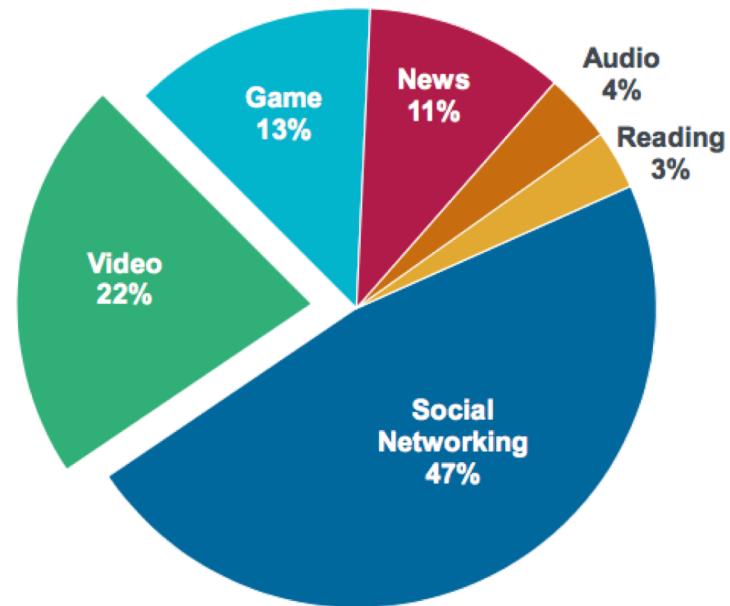
March 2016

2.0B Hours

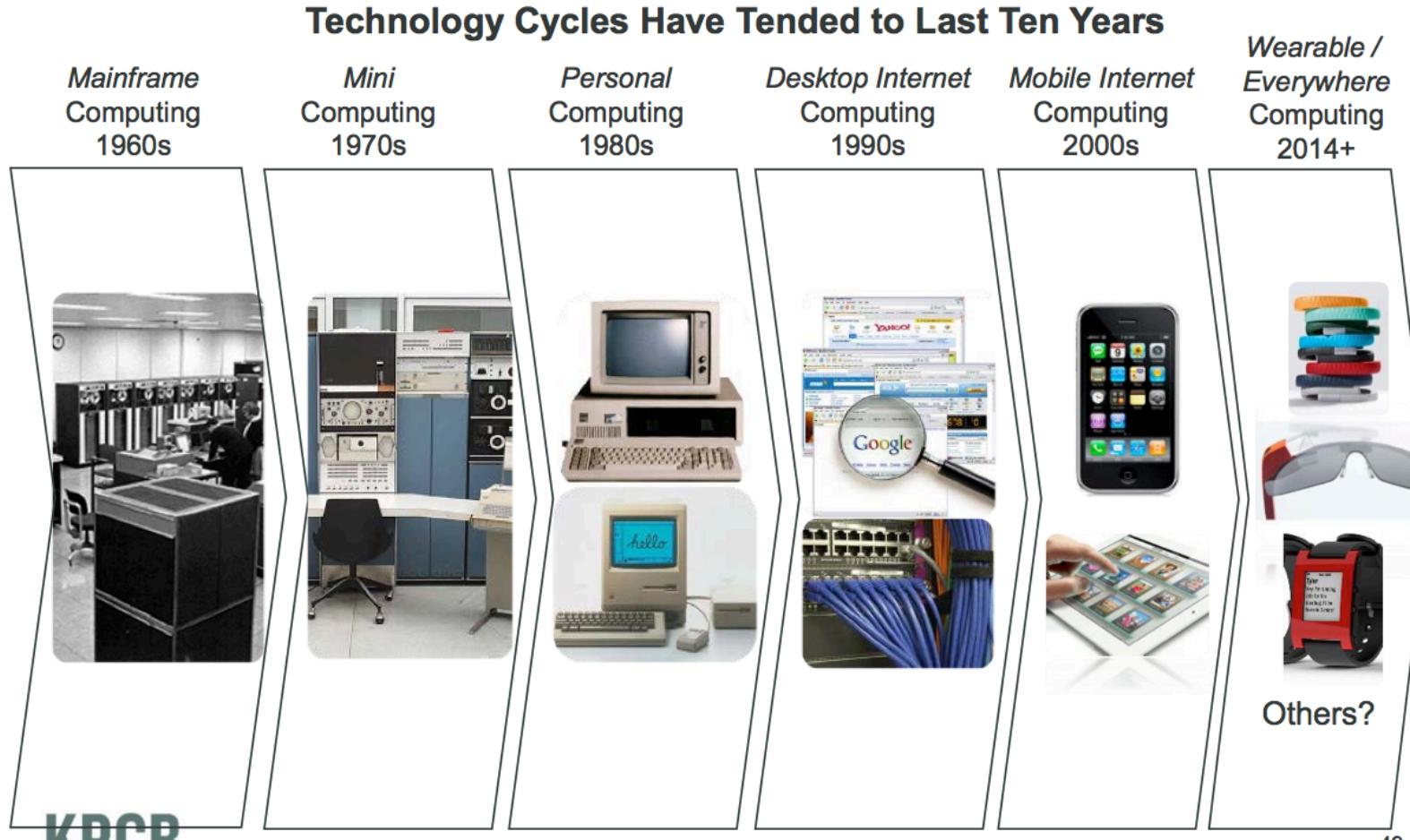


March 2018

3.2B Hours, +22% Y/Y

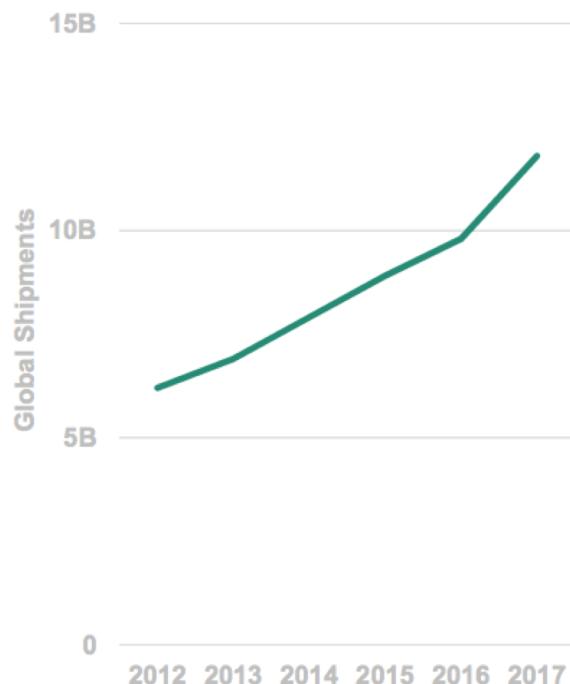


Technology Cycles – Still Early Cycle on Smartphones + Tablets, Now Wearables Coming on Strong, Faster than Typical 10-Year Cycle



...Data Gathering + Sharing + Optimization (2006 →) = Enabled by Sensor Pervasiveness...

MEMS Sensor / Actuator Shipments



Sensors + Data = In More Places



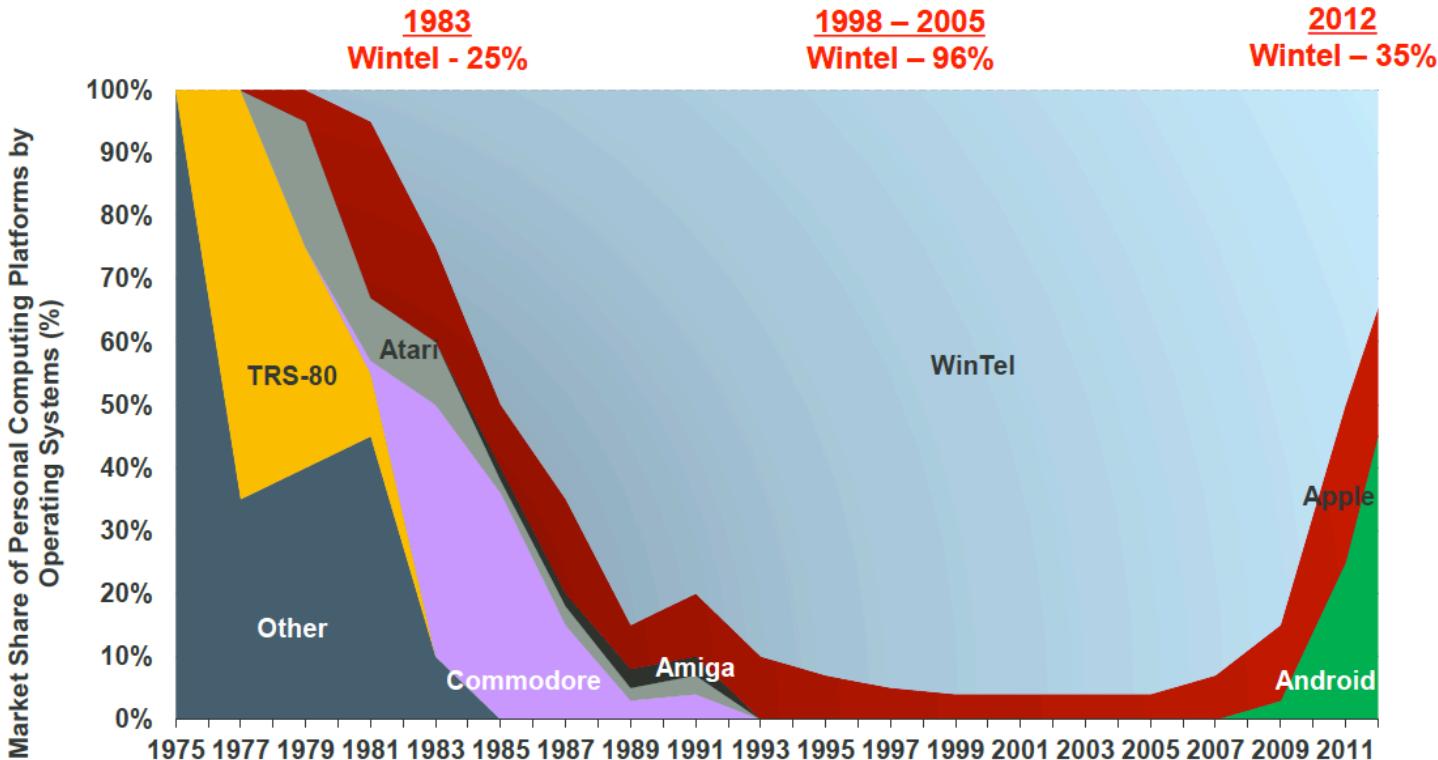
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2018
INTERNET TRENDS

Source: IC Insights (2018), Google Maps, Mobike, Nest, Samsara, Motiv, Joule. Note: MEMS sensors and actuators includes all MEMS-based sensors (e.g., Accelerometers, Gyroscopes, etc.), but does not include optical sensors, like CMOS image sensors, also includes actuators made using MEMS processes, per IC Insights.

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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...

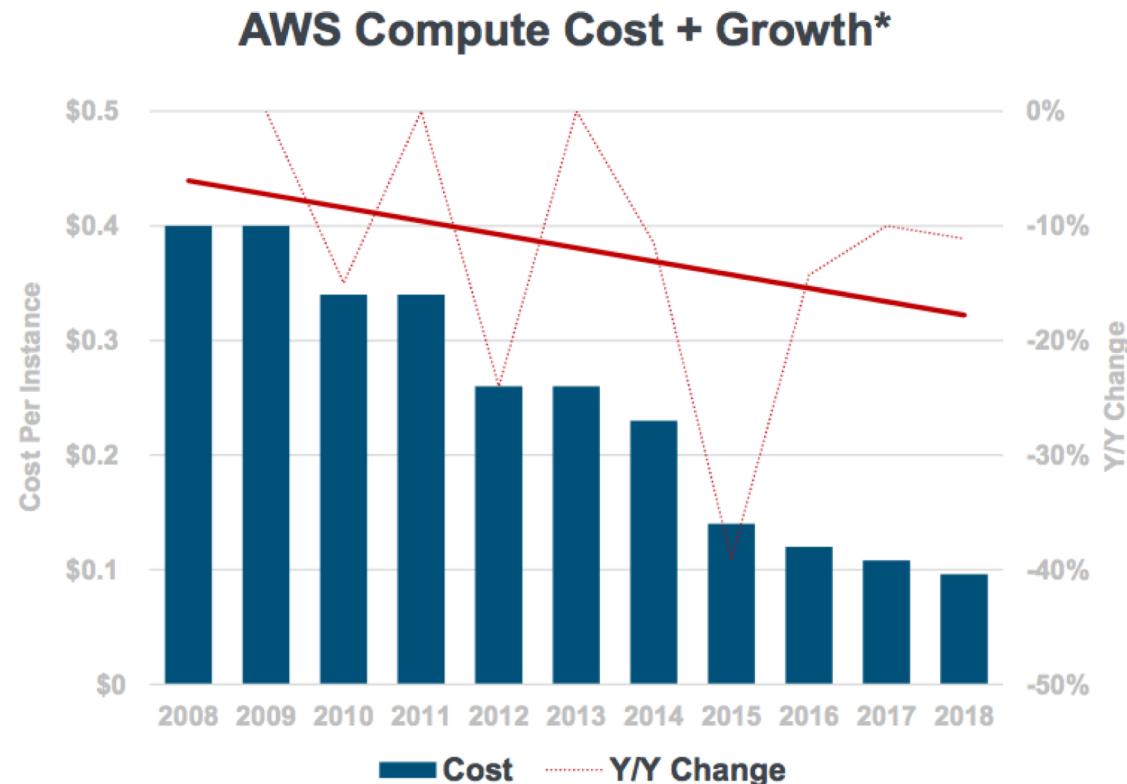


*Note: S3 is AWS' storage product and used as proxy for AWS scale / growth .
Source: Company data.



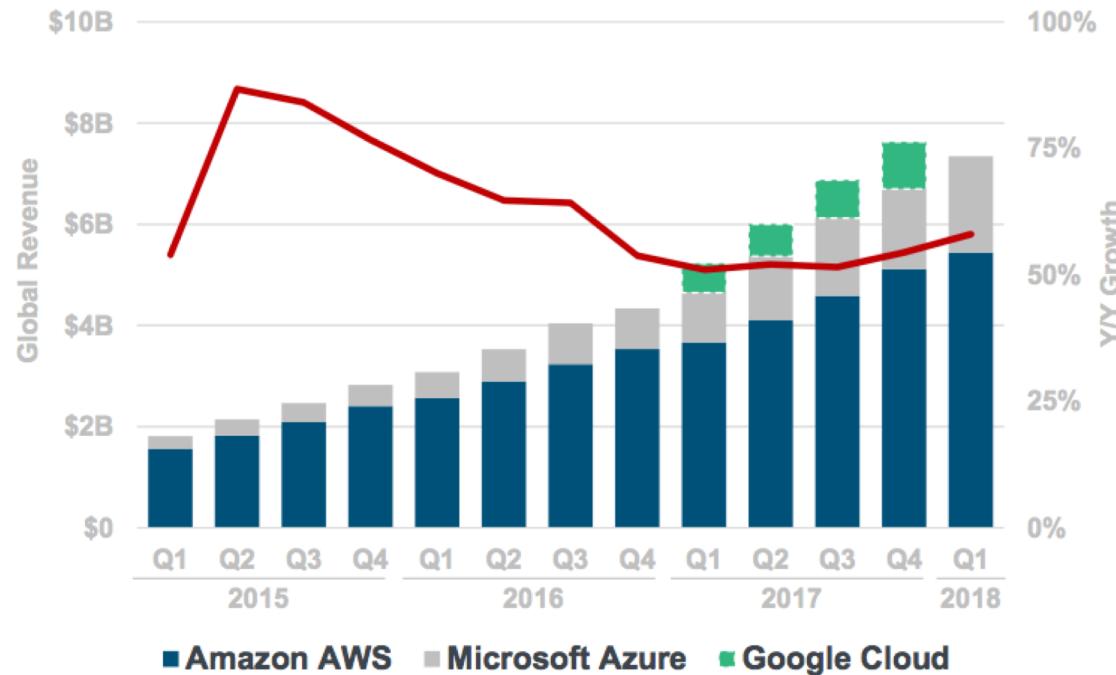
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...Computing Big Bangs Volume Effects = Cloud Compute Cost Declines Continue -11% vs. -10% Y/Y...

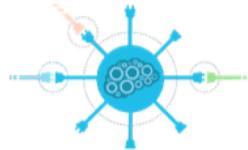


...Computing Big Bangs Volume Effects = Cloud Revenue Re-Accelerating +58% vs. +54% Q/Q

Cloud Service Revenue – Amazon + Microsoft + Google



Cloud Evolution / Tools = Paving Way for Innovation Across Infrastructure Landscape



New Methods of Software Delivery =

APIs / Browser Extensions creating new wave of capabilities (+ companies) for both companies and end users



Containers / Microservices =

Simplify software development process / improve consistency between testing & production environments / reduce complexity of managing & updating apps due to modular approach



Elastic Analytical Databases =

Likes of Google BigQuery / Snowflake / AWS Redshift Spectrum nearly infinitely scalable / usage based + have minimal maintenance requirements

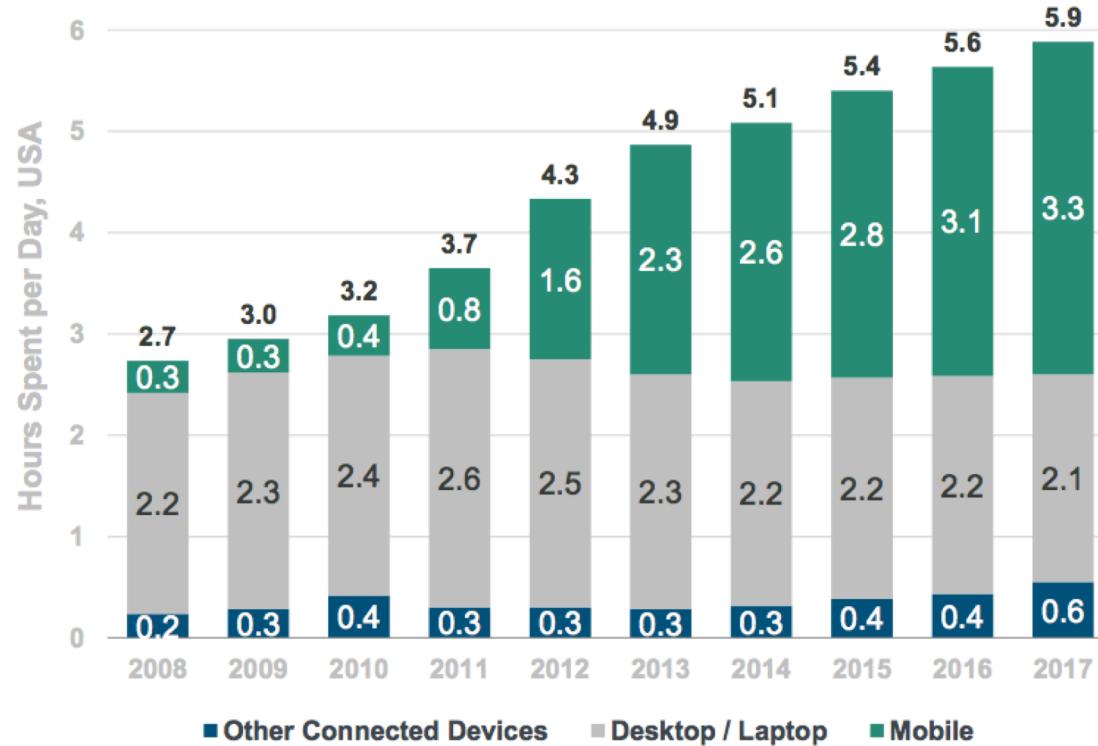


Edge Computing =

Pushing compute away from centralized nodes & closer to sources of data addresses many IT challenges when running data-centric workloads in cloud – reduces latency / can have security + compliance benefits

Digital Media Usage @ +4% Growth... 5.9 Hours per Day (Not Deduped)

Daily Hours Spent with Digital Media per Adult User



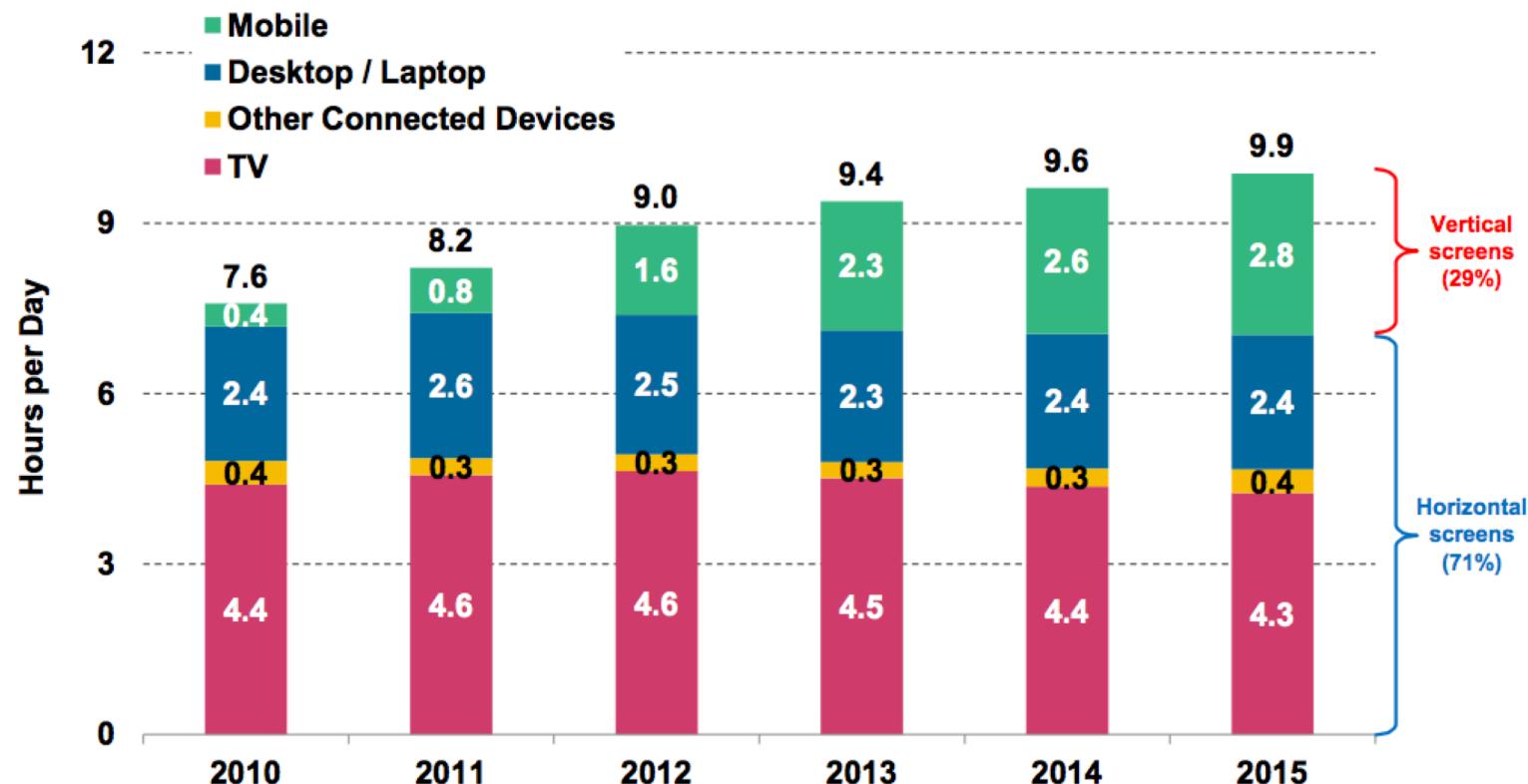
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2018
INTERNET TRENDS

Source: eMarketer 9/14 (2008-2010), eMarketer 4/15 (2011-2013), eMarketer 4/17 (2014-2016), eMarketer 10/17 (2017). Note: Other connected devices include OTT and game consoles. Mobile includes smartphone and tablet. Usage includes both home and work for consumers 18+. Non deduped defined as time spent with each medium individually, regardless of multitasking.

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...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



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Source: eMarketer 4/15, Coacute 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

Messaging = Extensibility Expanding

Messaging

Tencent (2000 → 2018)

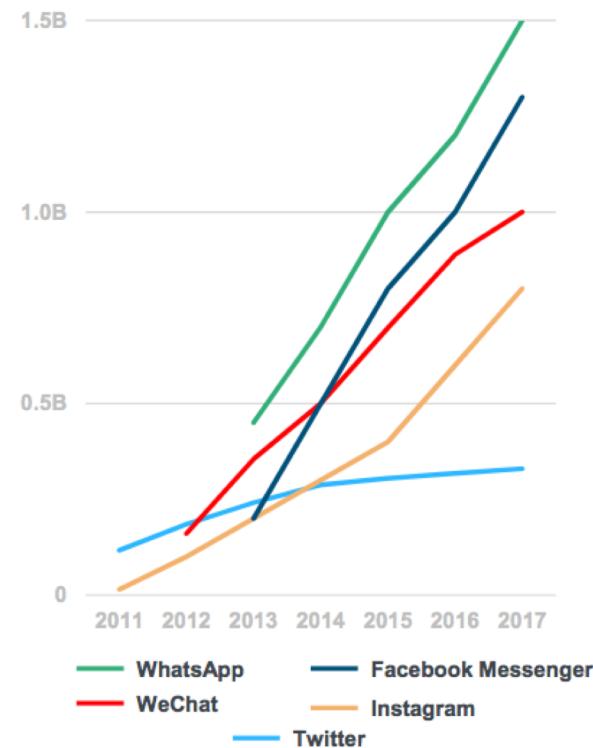
QQ



WeChat

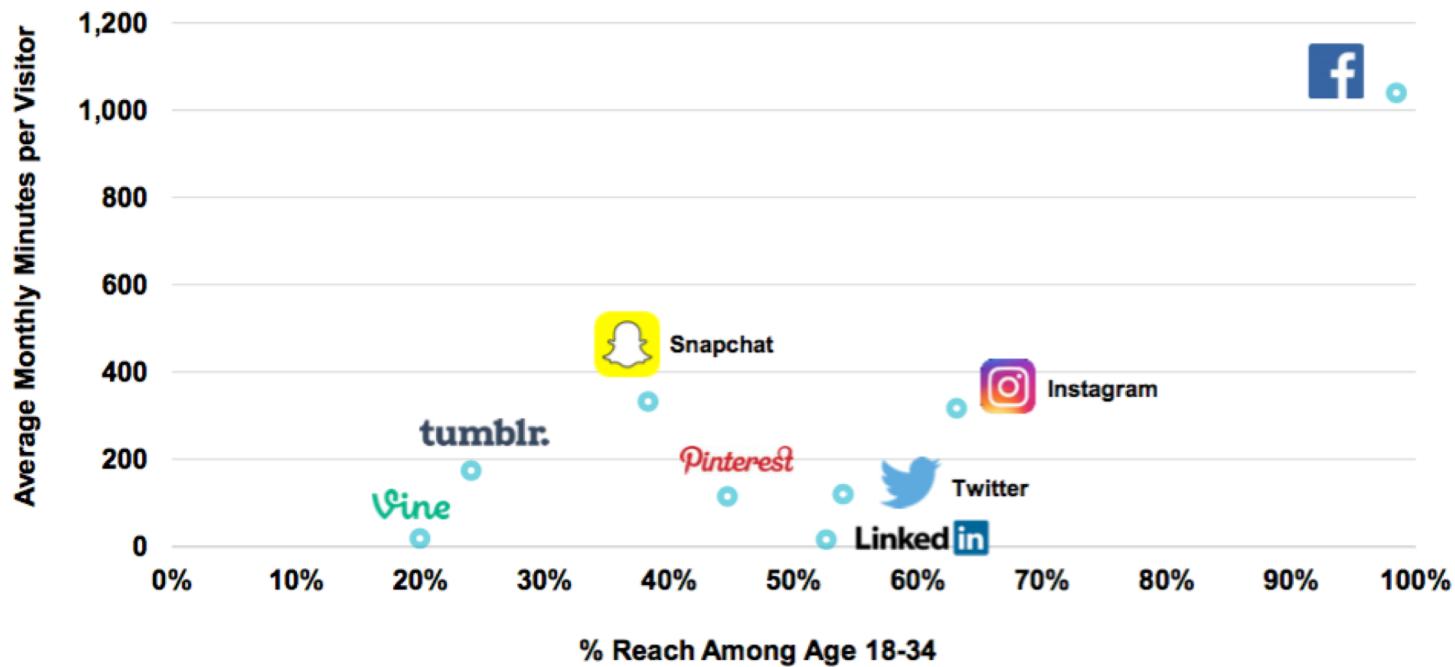


Messenger MAUs



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 / Yixun (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)

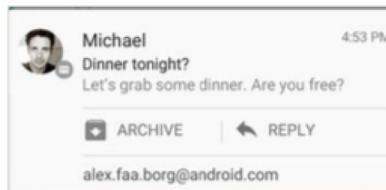
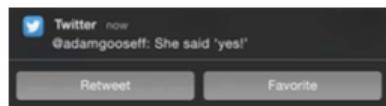
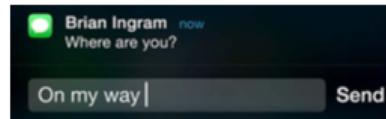
Average Global Mobile User = ~33 Apps...12 Apps Used Daily... 80% of Time Spent in 3 Apps

Day in Life of a Mobile User, 2016

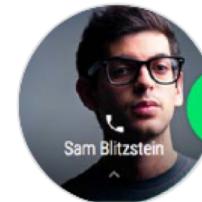
	Average # Apps Installed on Device*	Average Number of Apps Used Daily	Average Number of Apps Accounting for 80%+ of App Usage	Time Spent on Phone (per Day)	Most Commonly Used Apps
USA	37	12	3	5 Hours	Facebook Chrome YouTube
Worldwide	33	12	3	4 Hours	Facebook WhatsApp Chrome

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

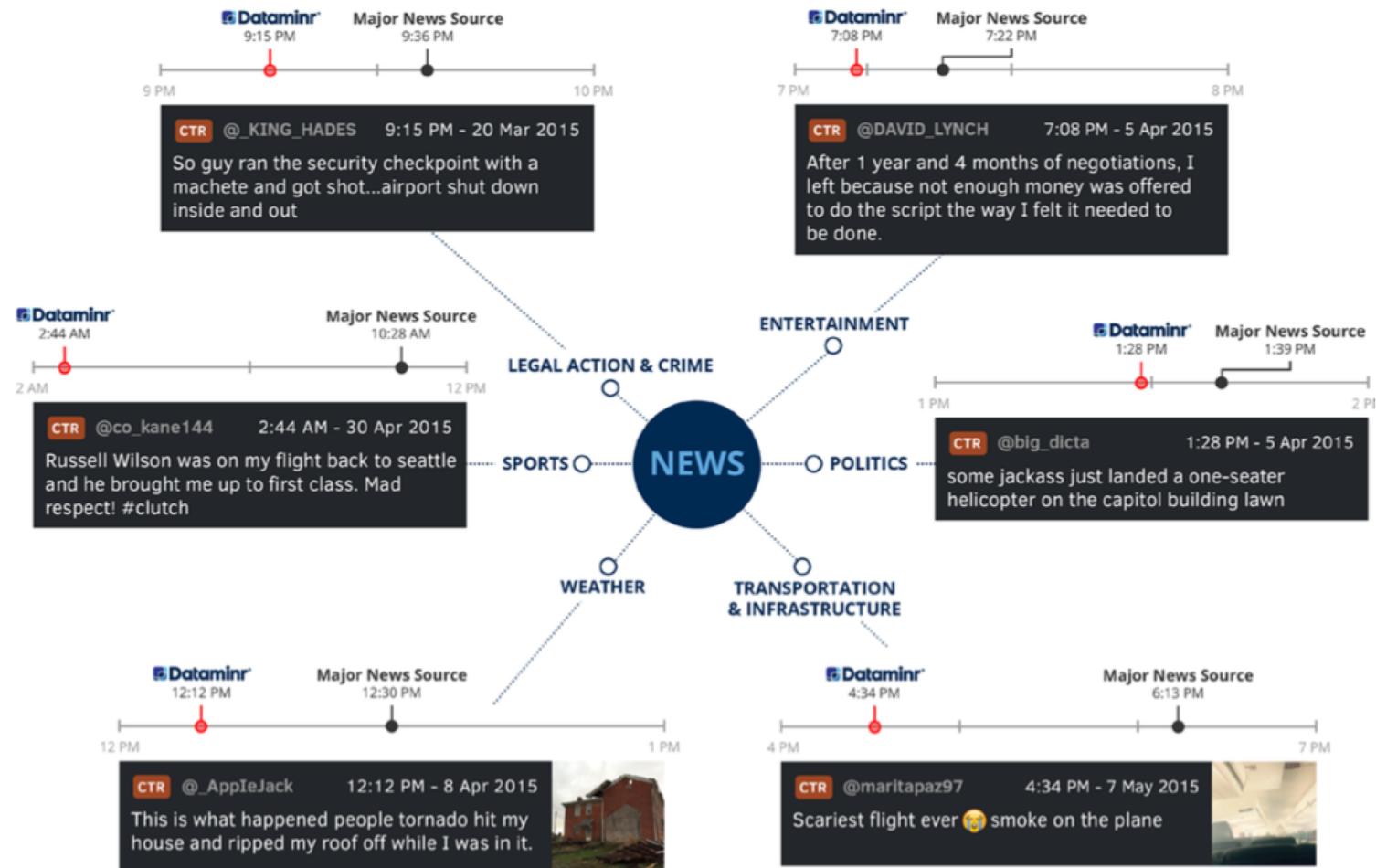
**Direct Interaction
on Notification Panel –**
without users interrupting
what they're doing...



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



Users Increasingly First Source for News via Twitter / Dataminr



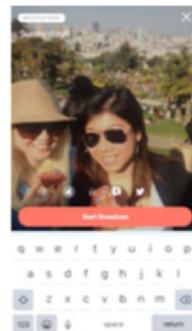
@KPCB

Source: Dataminr, 5/15.

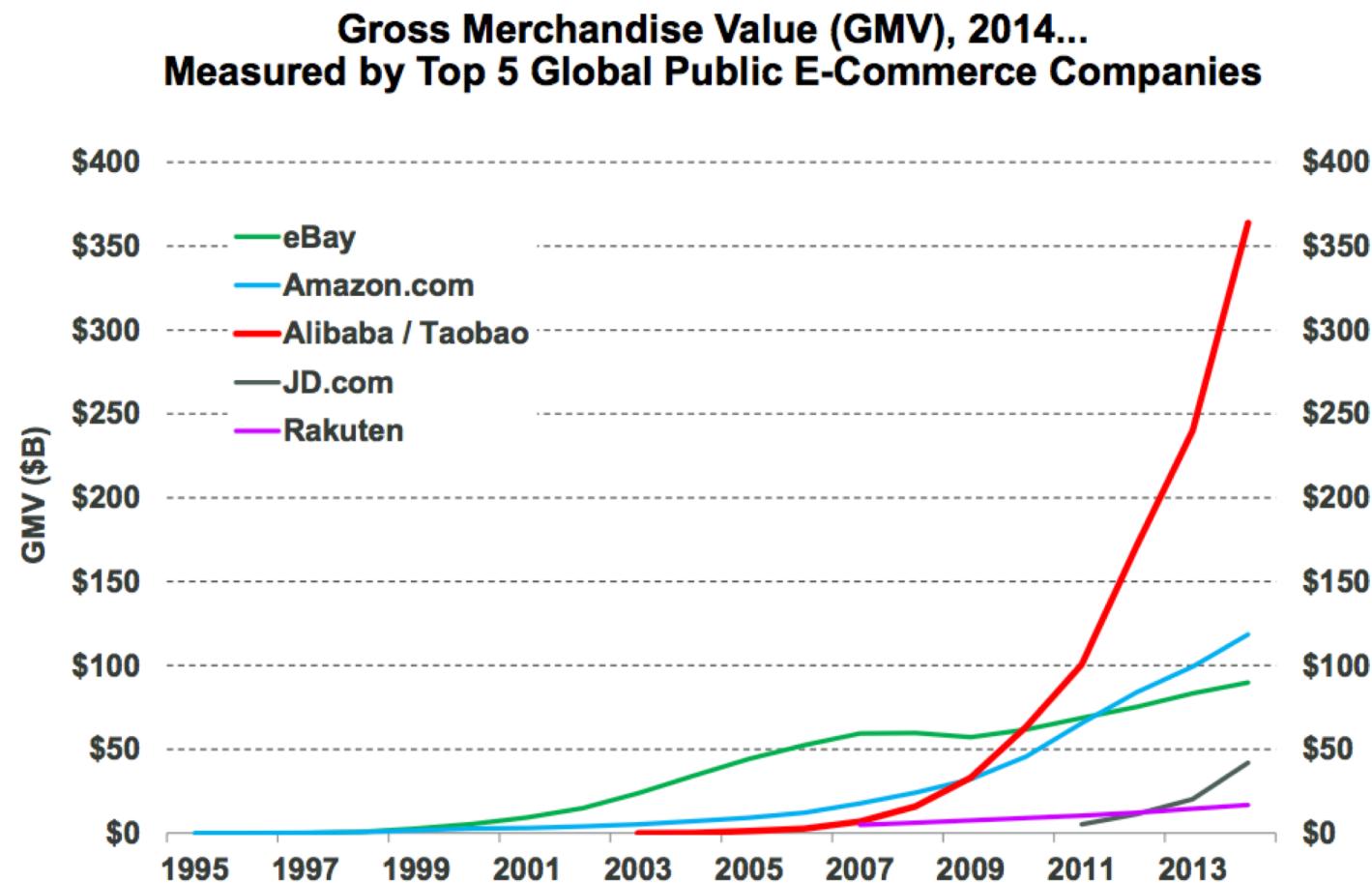
65

Video Evolution = Accelerating

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

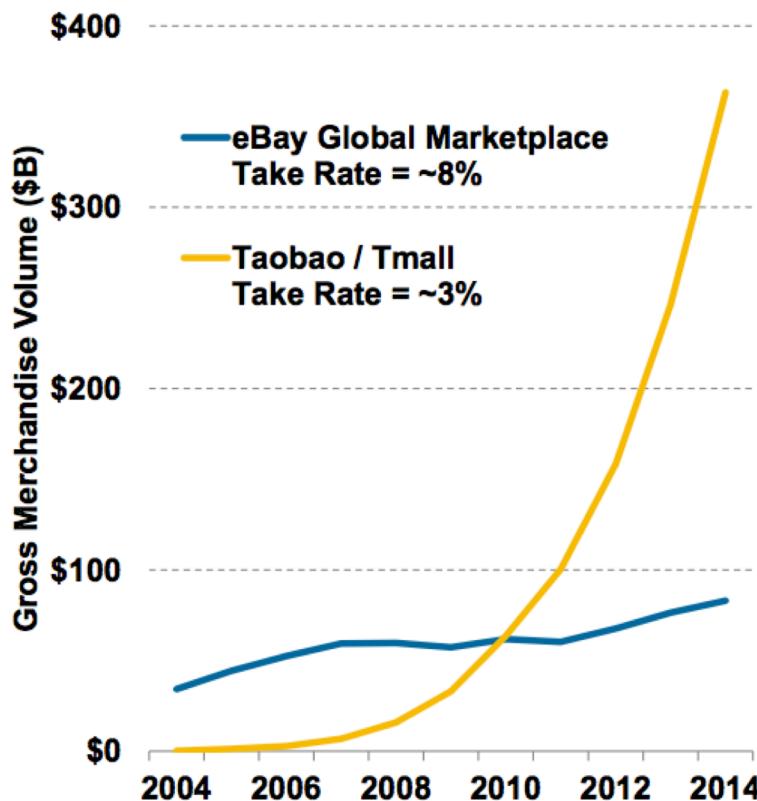
Live (Linear)	On-Demand	Semi-Live	Real-Live
<i>Traditional TV 1926</i>	<i>DVR / Streaming 1999</i>	<i>Snapchat Stories 2013</i>	<i>Periscope + Facebook Live 2015 / 2016</i>
Tune-In or Miss Out	Watch on Own Terms	Tune-In Within 24 Hours or Miss Out	Tune-In / Watch on Own Terms
Mass Concurrent Audience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

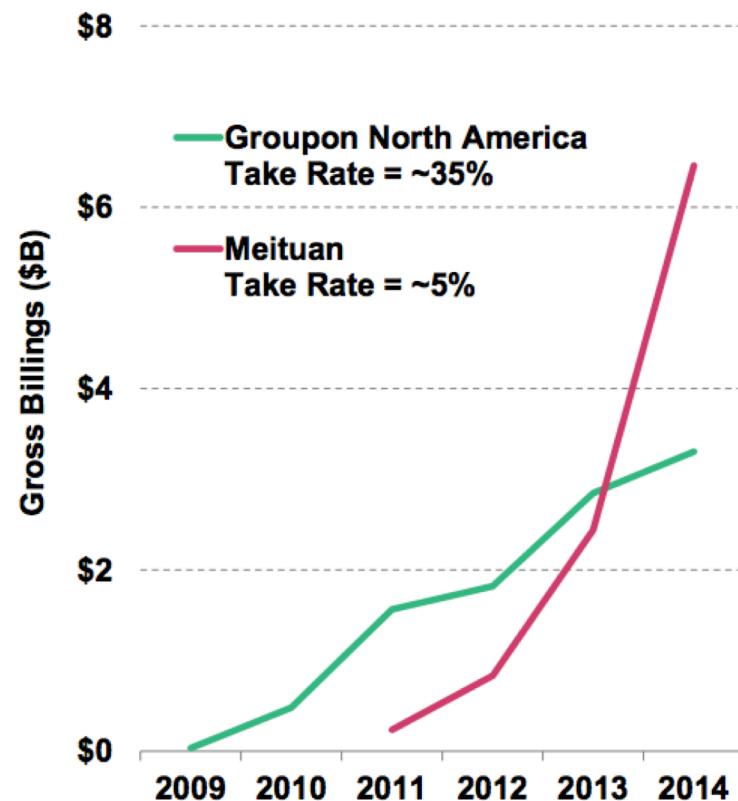


China E-Commerce = Low Take Rates* Helped China Marketplace Leaders Pass USA Peers

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



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



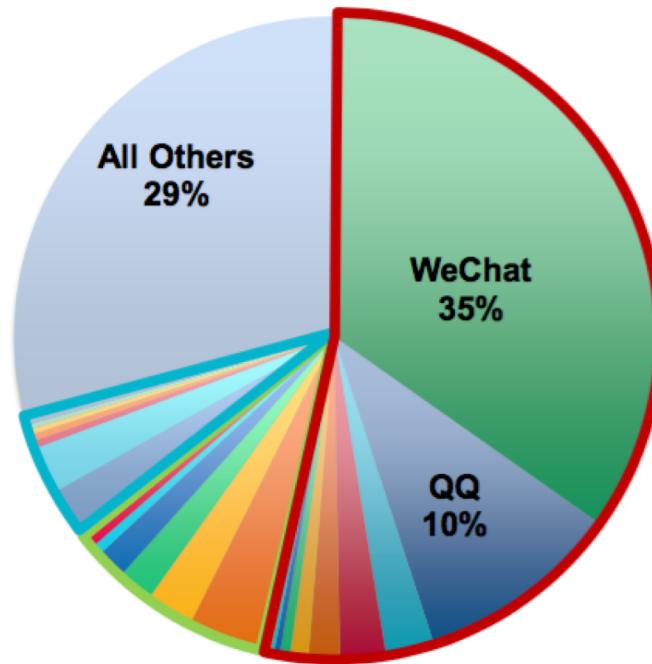
@KPCB

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

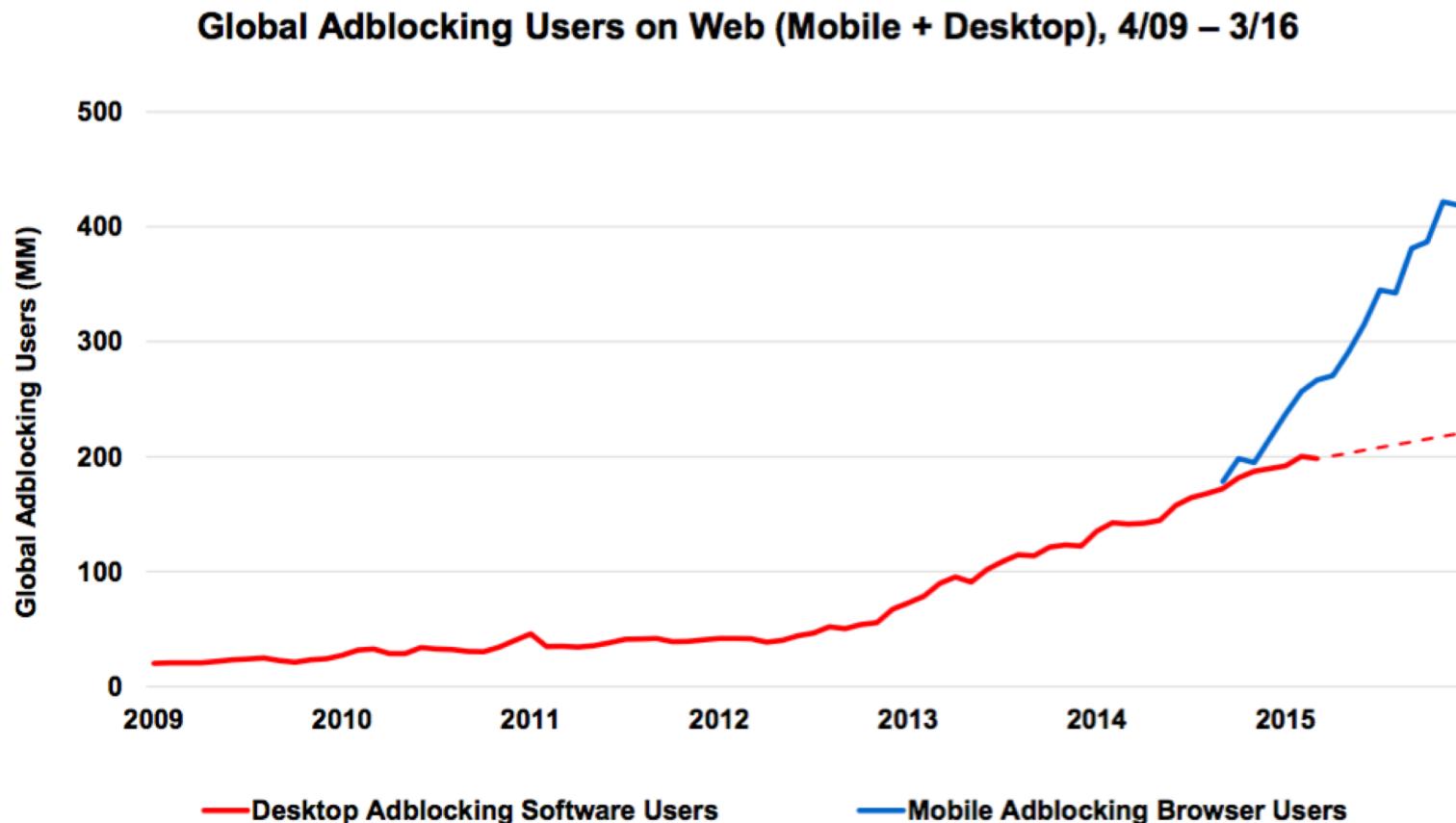
Alibaba

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

Baidu

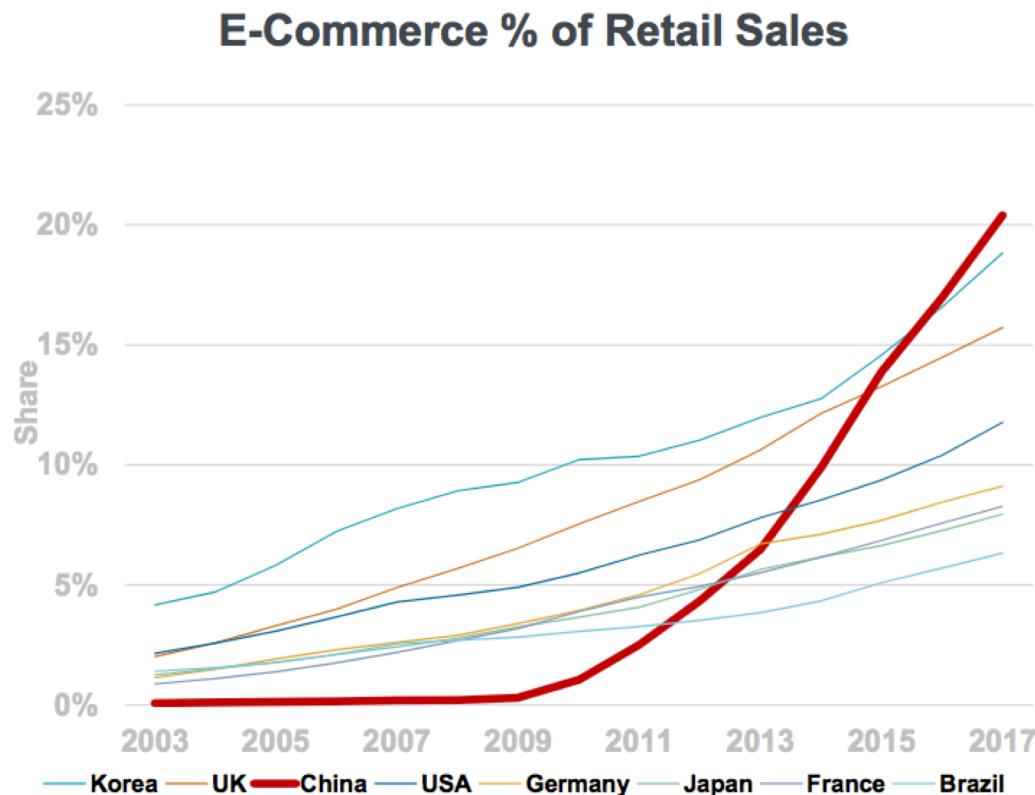
- Mobile Baidu
- iQiyi / PPS Video
- Baidu Browser
- Baidu Tieba
- 91 Desktop
- Baidu Maps
- All Other

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



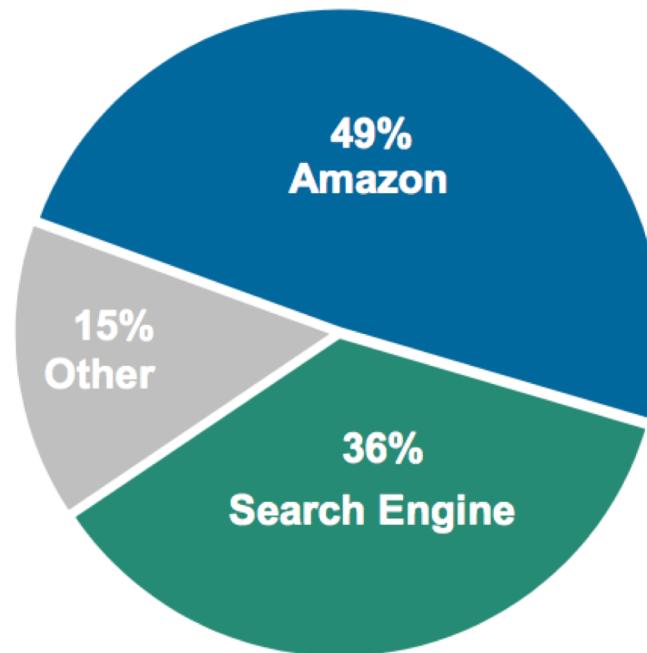
Source: PageFair, 5/16. Dotted line represents estimated data. These two data sets have not been de-duplicated. The number of desktop adblockers after 6/15 are estimates based on the observed trend in desktop adblocking and provided by PageFair. Note that mobile adblocking refers to web / browser-based 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.

Worldwide E-Commerce Share Gains Continue... China @ 20% = Highest Penetration Rate + Fastest Growing



Product Finding = Often Starts @ Search (Amazon + Google...)

Where Do You Begin Your Product Search?



Product Finding (Amazon) = Started @ Search...Fulfilled by Amazon

Product Search



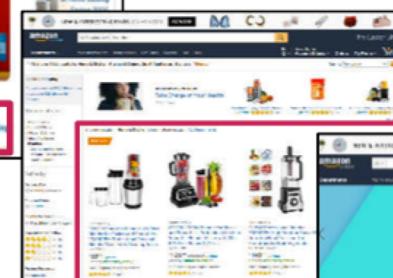
1-Click
Purchasing



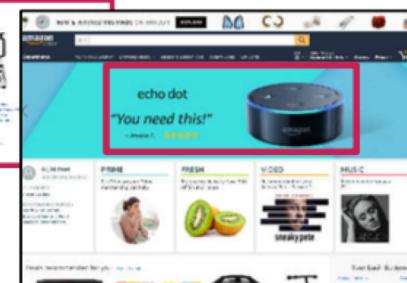
Prime
Fulfillment



Sponsored
Product Listings



Voice
Search + Fulfillment



Product Finding (Google) = Started @ Search...Fulfilled by Others

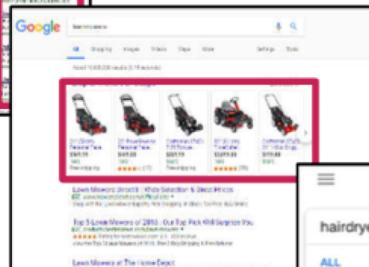
Organic Search



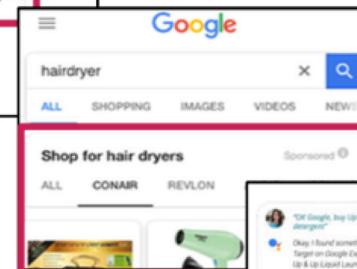
Paid
Search



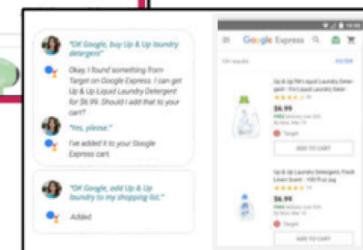
Google
Shopping



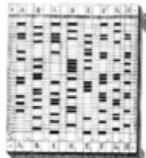
Product
Listing Ads



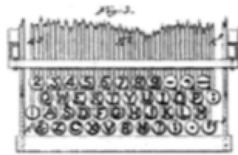
Shopping
Actions



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

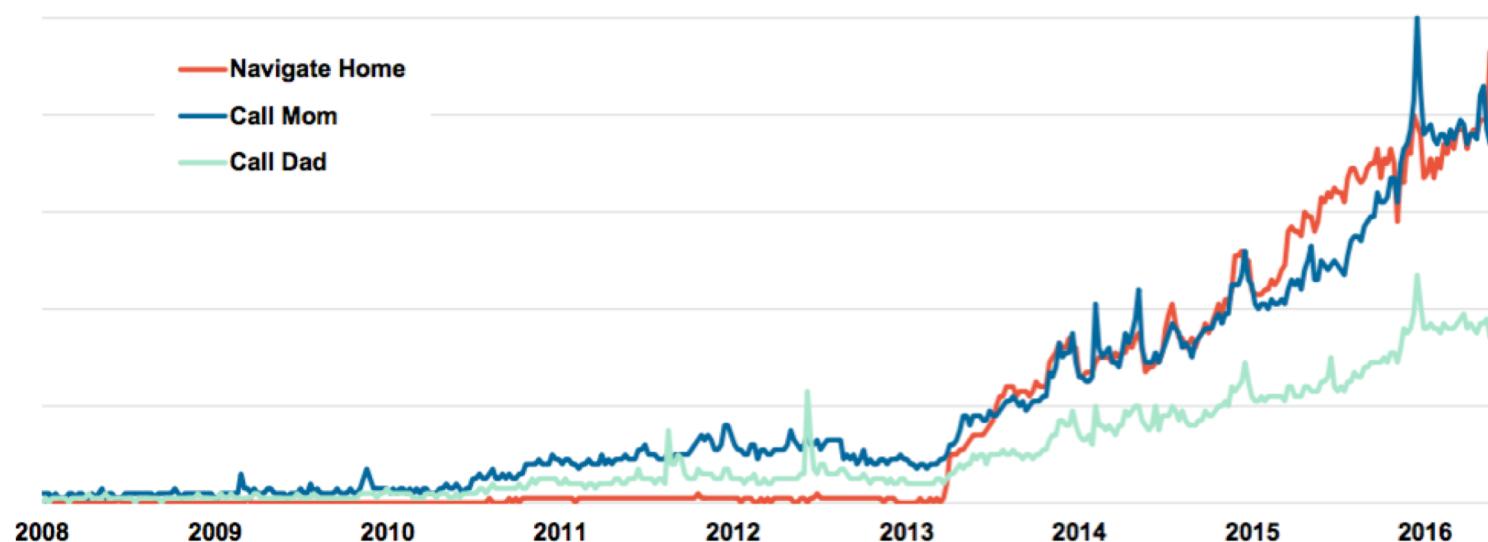


Voice on Connected /
Ambient Devices
(Amazon Echo)
2014

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

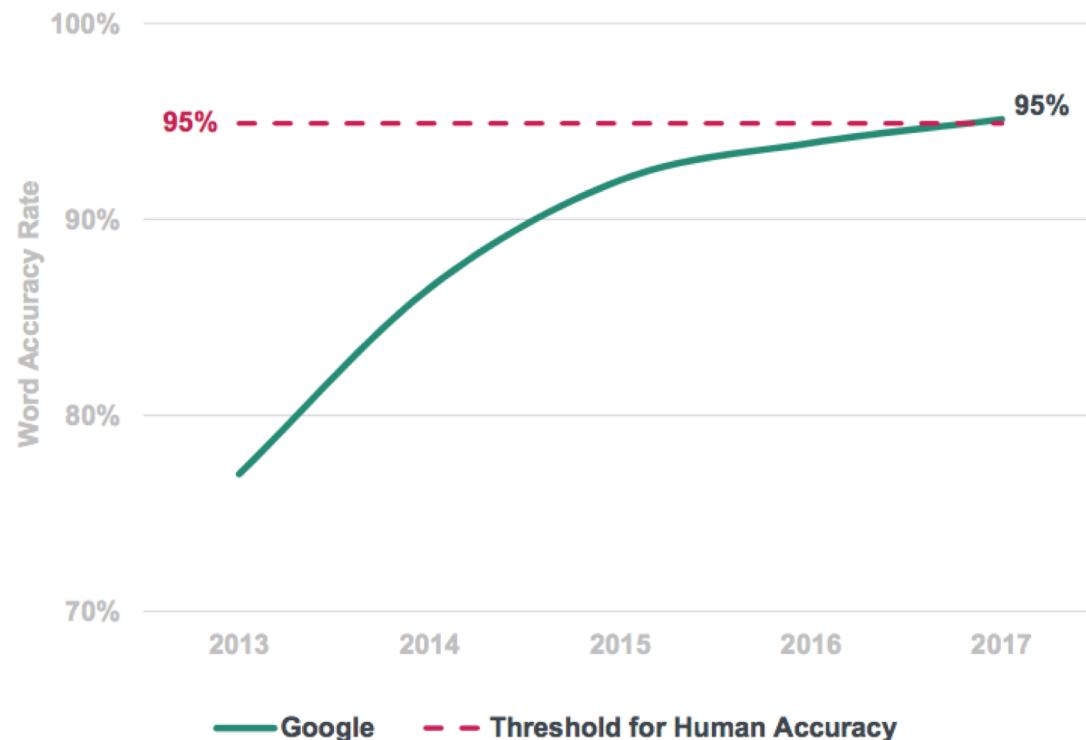
Google Trends imply queries associated with voice-related commands have risen >35x since 2008 after launch of iPhone & Google Voice Search

Google Trends, Worldwide, 2008 – 2016



Voice =
Technology Lift Off...

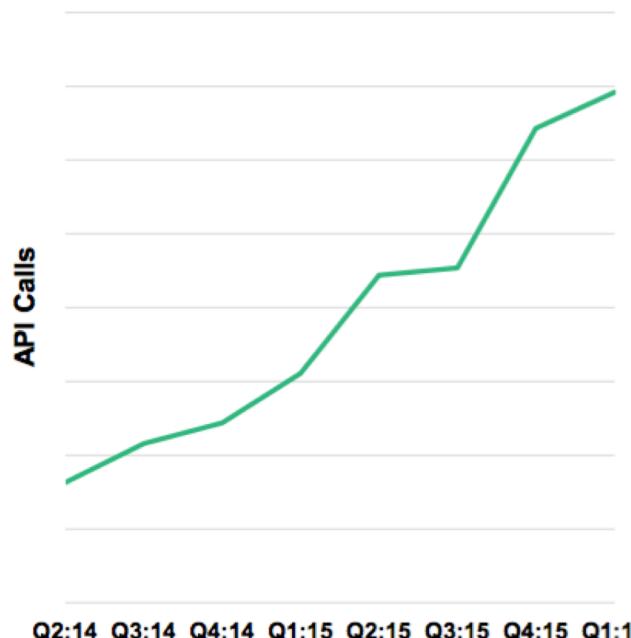
Google Machine Learning Word Accuracy



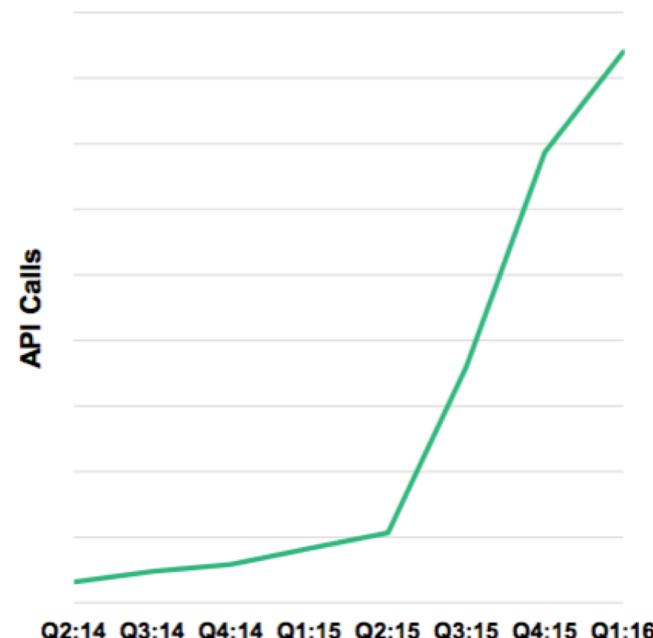
Baidu Voice = Input Growth >4x...Output >26x, Since Q2:14

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.

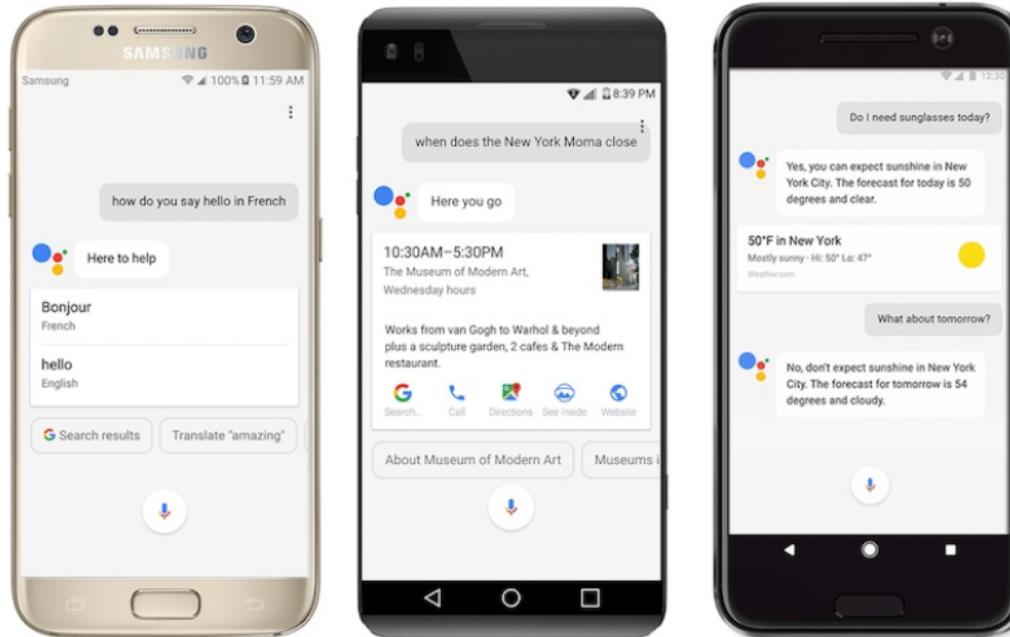


Voice-Based Mobile Platform Front-Ends = Voice Can Replace Typing

Google Assistant

Nearly 70% of Requests are Natural / Conversational Language, 5/17

20% of Mobile Queries Made via Voice, 5/16



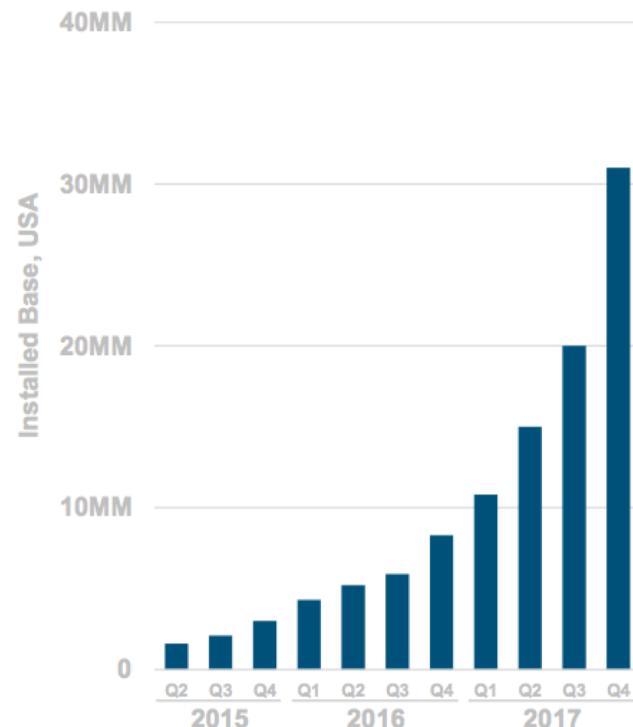
KLEINER
PERKINS

Source: Google I/O (5/16), Image: Macrumors (2/17)

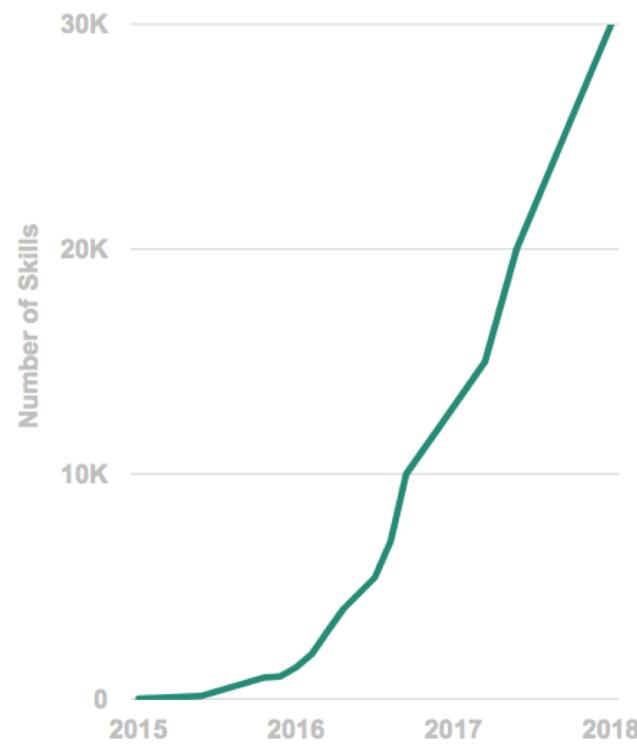
KP INTERNET TRENDS 2017 | PAGE 46

...Voice = Product Lift Off

Amazon Echo Installed Base



Amazon Echo Skills



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



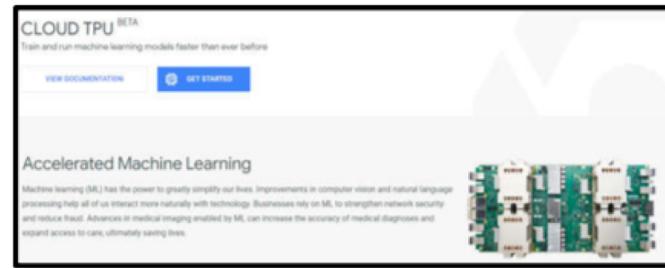
...Google = AI Platform Emerging from Google Cloud... Enabling Easier Data Processing / Collection for Others

Google Cloud AI Services / Infrastructure

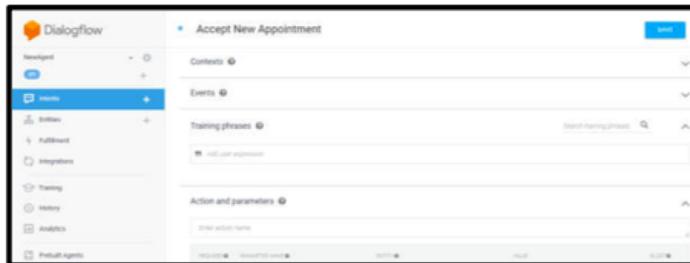
Google Cloud Vision API



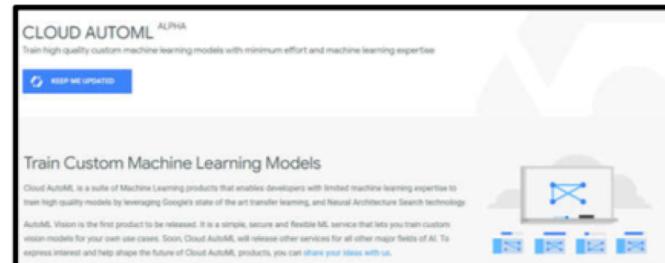
AI Hardware – Tensor Processing Units



Dialogflow Conversational Platform

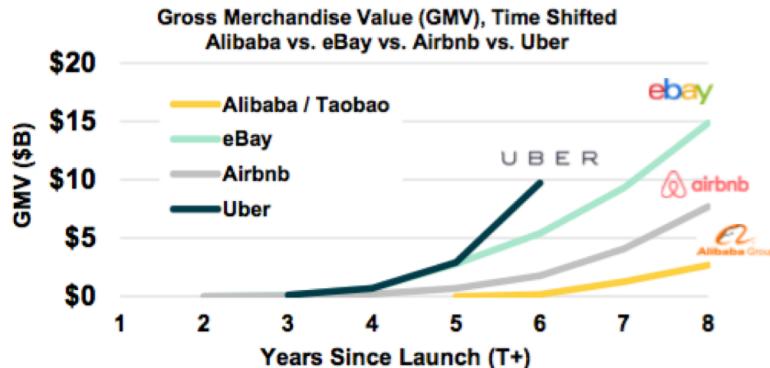


Cloud AutoML – Custom Models



Current Generation of Internet Leaders = Growing Faster than Previous Generation

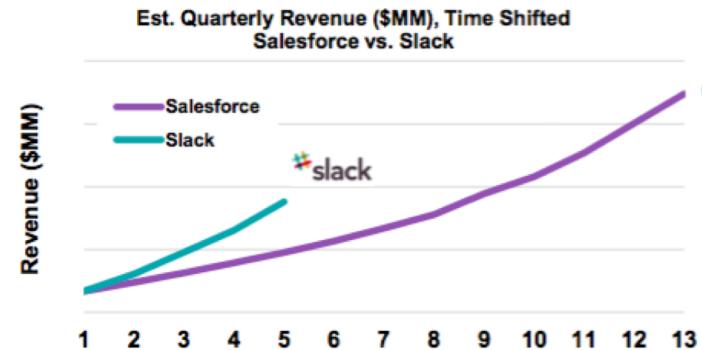
Marketplaces



Commerce



Enterprise



@KPCB

Marketplaces Source: Company data, Morgan Stanley Research. eBay founded in 1995. Amazon founded in 1995. Alibaba.com founded in 1999 as B2B portal connecting Chinese manufacturers and overseas buyers. Uber launched 2009, gave first ride in 2010. Airbnb founded in 2008. Commerce Source: Publicly available company data, Morgan Stanley Research. JD.com launched B2C shipments in 2004, founded 1998 as an online magneto-optical store. Amazon founded in 1995. Enterprise Source: Slack. Graph starting point based on similar est. revenue figures. Salesforce quarterly revenue approximated from publicly disclosed annual GAAP revenues.

KPCB INTERNET TRENDS 2016 | PAGE 185

Today's Top 20 Worldwide Internet Leaders 5 Years Ago* = USA @ 9...China @ 2...

Public / Private Internet Companies, Ranked by Market Valuation (5/29/18)

Rank	2018 Company	Region	Market Value (\$B)	
			5/29/13	Total
1)	Apple	USA	\$418	
2)	Amazon	USA	121	
3)	Microsoft	USA	291	
4)	Google / Alphabet	USA	288	
5)	Facebook	USA	56	
6)	Alibaba	China	--	
7)	Tencent	China	71	
8)	Netflix	USA	13	
9)	Ant Financial	China	--	
10)	eBay + PayPal**	USA	71	
11)	Booking Holdings	USA	41	
12)	Salesforce.com	USA	25	
13)	Baidu	China	34	
14)	Xiaomi	China	--	
15)	Uber	USA	--	
16)	Didi Chuxing	China	--	
17)	JD.com	China	--	
18)	Airbnb	USA	--	
19)	Meituan-Dianping	China	--	
20)	Toutiao	China	--	
			Total	\$1,429

Source: CapIQ, CB Insights, The Wall Street Journal, media reports. *Only includes public companies in 2013. **eBay + PayPal combined for comparison purposes though PayPal spun-off of eBay on 7/20/15.

...Today's Top 20 Worldwide Internet Leaders *Today* = USA @ 11...China @ 9

Public / Private Internet Companies, Ranked by Market Valuation (5/29/18)

Rank 2018	Company	Region	Market Value (\$B)	
			5/29/13	5/29/18
1)	Apple	USA	\$418	\$924
2)	Amazon	USA	121	783
3)	Microsoft	USA	291	753
4)	Google / Alphabet	USA	288	739
5)	Facebook	USA	56	538
6)	Alibaba	China	--	509
7)	Tencent	China	71	483
8)	Netflix	USA	13	152
9)	Ant Financial	China	--	150
10)	eBay + PayPal*	USA	71	133
11)	Booking Holdings	USA	41	100
12)	Salesforce.com	USA	25	94
13)	Baidu	China	34	84
14)	Xiaomi	China	--	75
15)	Uber	USA	--	72
16)	Didi Chuxing	China	--	56
17)	JD.com	China	--	52
18)	Airbnb	USA	--	31
19)	Meituan-Dianping	China	--	30
20)	Toutiao	China	--	30
		Total	\$1,429	\$5,788

Source: CapiQ, CB Insights, Wall Street Journal, media reports. *eBay + PayPal combined for comparison purposes though PayPal spin-off of eBay on 7/20/15. Market value data as of 5/29/18. The Wall Street Journal, Recode, TechCrunch, Reuters, and the Information articles detail the latest valuations for Ant Financial (4/18), Xiaomi (5/18), Uber (2/18), Didi Chuxing (12/17), Airbnb (3/17), Meituan-Dianping (10/17), and Toutiao (12/17).

USA = 56% of Most Highly Valued Tech Companies Founded By... 1st or 2nd Generation Americans...1.7MM Employees, 2017

Immigrant Founders / Co-Founders of Top 25 USA Valued Public Tech Companies, Ranked by Market Capitalization

Rank	Company	Mkt Cap (\$MM)	LTM Rev (\$MM)	Employees	Founder / Co-Founder (1st / 2nd Gen Immigrant)	Generation
1	Apple	\$923,554	\$239,176	123,000	Steve Jobs	2 nd – Syria
4	Amazon.com	782,608	177,866	566,000	Jeff Bezos	2 nd – Cuba
3	Microsoft	753,030	95,652	124,000	--	--
2	Alphabet / Google	739,122	110,855	80,110	Sergey Brin	1 st – Russia
5	Facebook	537,648	40,653	25,105	Eduardo Saverin	1 st – Brazil
6	Intel	257,791	62,761	102,700	--*	--
7	Cisco	202,083	48,096	72,900	--	--
8	Oracle	188,848	39,472	138,000	Larry Ellison / Bob Miner	2 nd – Russia / 2 nd – Iran
11	Netflix	152,025	11,693	4,850	--	--
10	NVIDIA	150,894	9,714	10,299	Jensen Huang	1 st – Taiwan
9	IBM	129,635	79,139	366,600	Herman Hollerith	2 nd – Germany
12	Adobe Systems	119,271	7,699	17,973	--	--
13	Booking.com	100,013	12,681	22,900	--	--
14	Texas Instruments	108,912	14,961	29,714	Cecil Green / J. Erik Jonsson Max Levchin / Luke Nosek / Peter Thiel / Elon Musk***	1 st – UK / 2 nd – Sweden 1 st – Ukraine / 1 st – Poland / 1 st – Germany / 1 st – South Africa
15	PayPal	95,858	13,094	18,700		
16	Salesforce.com	94,260	10,480	25,000	--	--
17	Qualcomm	86,333	22,360	33,800	Andrew Viterbi	1 st – Italy
19	Automatic Data Processing	57,237	12,790	58,000	Henry Taub	2 nd – Poland
21	VMware	55,282	7,922	20,615	Edouard Bugnion	1 st – Switzerland
20	Activision Blizzard	53,772	7,017	9,625	--	--
18	Applied Materials	52,439	15,463	18,400	--	--
23	Intuit	50,471	5,434	8,200	--	--
22	Cognizant Technology	43,597	14,810	260,000	Francisco D'Souza / Kumar Mahadeva	1 st – India** / 1 st – Sri Lanka
24	eBay	37,304	9,567	14,100	Pierre Omidyar	1 st – France
25	Electronic Arts	34,763	4,845	8,800	--	--

KLEINER PERKINS
2018
INTERNET TRENDS

Source: CapIQ as of 4/16/18. "The 'New American' Fortune 500" (2011), a report by the Partnership for a New American Economy, as well as "Reason for Reform: Entrepreneurship" (10/16). "American Made, The Impact of Immigrant Founders & Professionals on U.S. Corporations." *While Andy Grove (from Hungary) is not a co-founder of Intel, he joined as COO on the day it was incorporated. **Francisco D'Souza is a person of Indian origin born in Kenya. ***Max Levchin / Luke Nosek / Peter Thiel's startup Confinity merged with Elon Musk's startup X.com to form PayPal in 3/00.

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USA = Many Highly Valued Private Tech Companies Founded By... 1st Generation Immigrants

Company	Immigrant Founder / Co-Founder	Country of Origin	Market Value (\$B)
Uber	Garrett Camp	Canada	\$72
SpaceX	Elon Musk	South Africa	25
Palantir	Peter Thiel	Germany	21
WeWork	Adam Neumann	Israel	21
Stripe	John Collison, Patrick Collison	Ireland	9
Wish (ContextLogic)	Peter Szulczewski, Danny Zhang	Canada	9
Moderna Therapeutics	Noubar Afeyan, Derrick Rossi	Armenia / Canada	8
Robinhood	Baiju Bhatt, Vlad Tenev	India / Bulgaria	6
Slack	Stewart Butterfield, Serguei Mourachov, Cal Henderson	Canada / Russia / UK	5
Tanium	David Hindawi	Iraq	5
Credit Karma	Kenneth Lin	China	4
Houzz	Adi Tatarko, Alon Cohen	Israel	4
Instacart	Apoorva Mehta	India	4
Bloom Energy	KR Sridhar	India	3
Oscar Health	Mario Schlosser	Germany	3
Unity Technologies	David Helgason	Iceland	3
Avant	Al Goldstein, John Sun, Paul Zhang	Uzbekistan / China / China	2
Zenefits	Laks Srini	India	2
AppNexus	Mike Nolet	Holland	2
ZocDoc	Oliver Kharraz	Germany	2
Sprinklr	Ragy Thomas	India	2
Compass	Ori Allon	Israel	2

Company	Immigrant Founder / Co-Founder	Country of Origin	Market Value (\$B)
JetSmarter	Sergey Petrossov	Russia	\$2
Warby Parker	Dave Gilboa	Sweden	2
Carbon3D	Alex Ermoshkin	Russia	2
Infinidat	Moshe Yanai	Israel	2
Tango	Uri Raz, Eric Setton	Israel / France	2
Quanergy	Louay Eldada, Tianyue Yu	Lebanon / China	2
Zoox	Tim Kentley-Klay	Australia	2
Eventbrite	Renaud Visage	France	2
Apttus	Kirk Krappe	UK	2
Cloudflare	Michelle Zatlyn	Canada	2
Proteus Digital Health	Andrew Thompson	UK	2
Anaplan	Guy Haddleton, Michael Gould	New Zealand / UK	1
Rubrik	Bipul Sinha	India	1
OfferUp	Arean Van Veenen	Netherlands	1
Actifio	Ash Ashutosh	India	1
Gusto	Tomer London	Israel	1
Medallia	Borge Hald	Norway	1
FanDuel	Nigel Eccles, Tom Griffiths, Lesley Eccles	UK	1
AppDirect	Daniel Saks, Nicolas Desmarais	Canada	1
Evernote	Stepan Pachikov, Phil Libin	Azerbaijan / Russia	1
Udacity	Sebastian Thrun	Germany	1
UiPath*	Daniel Dines, Marius Tirca	Romania	1
Zoom Video	Eric Yuan	China	1

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

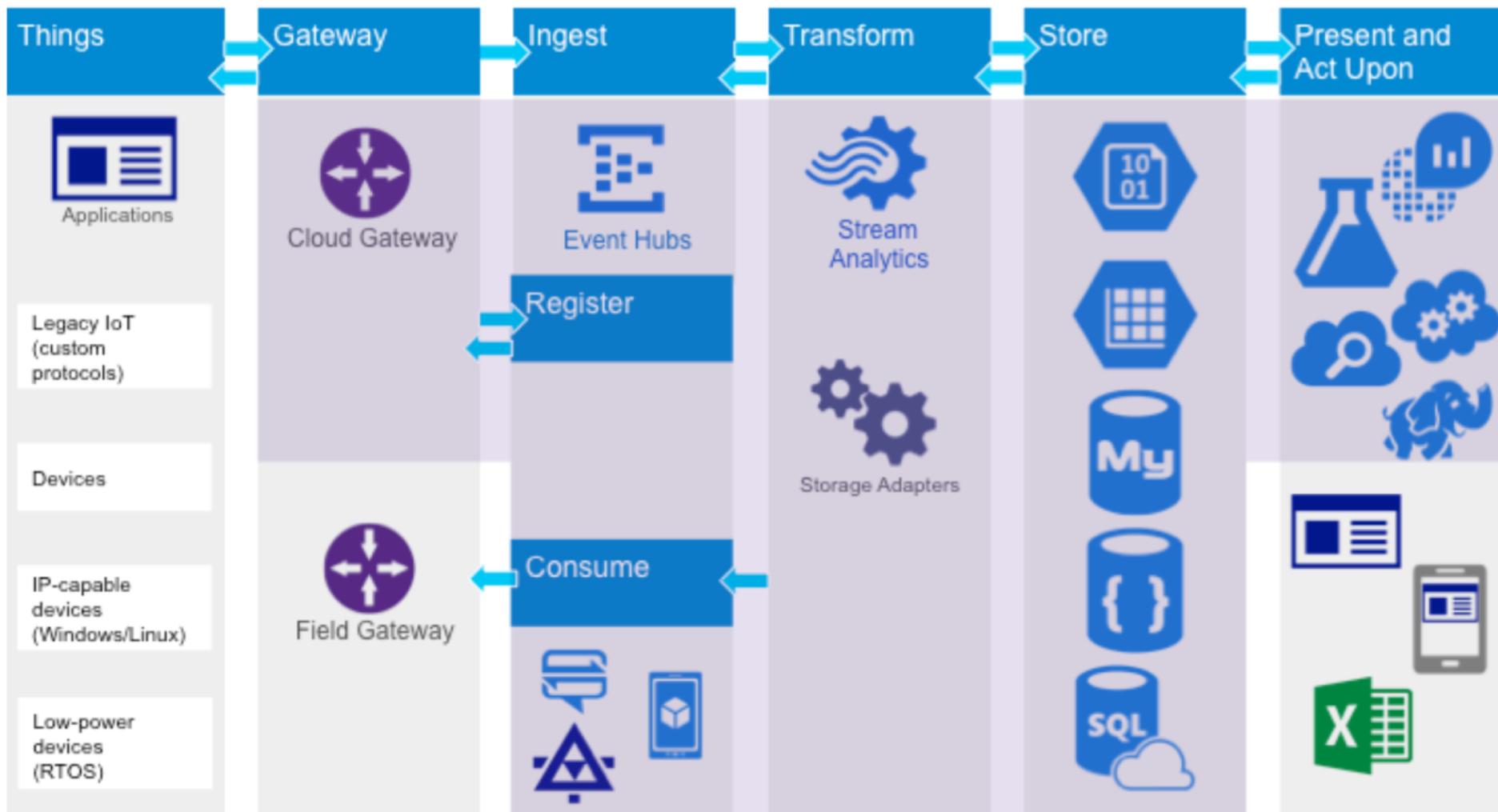


Health



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:

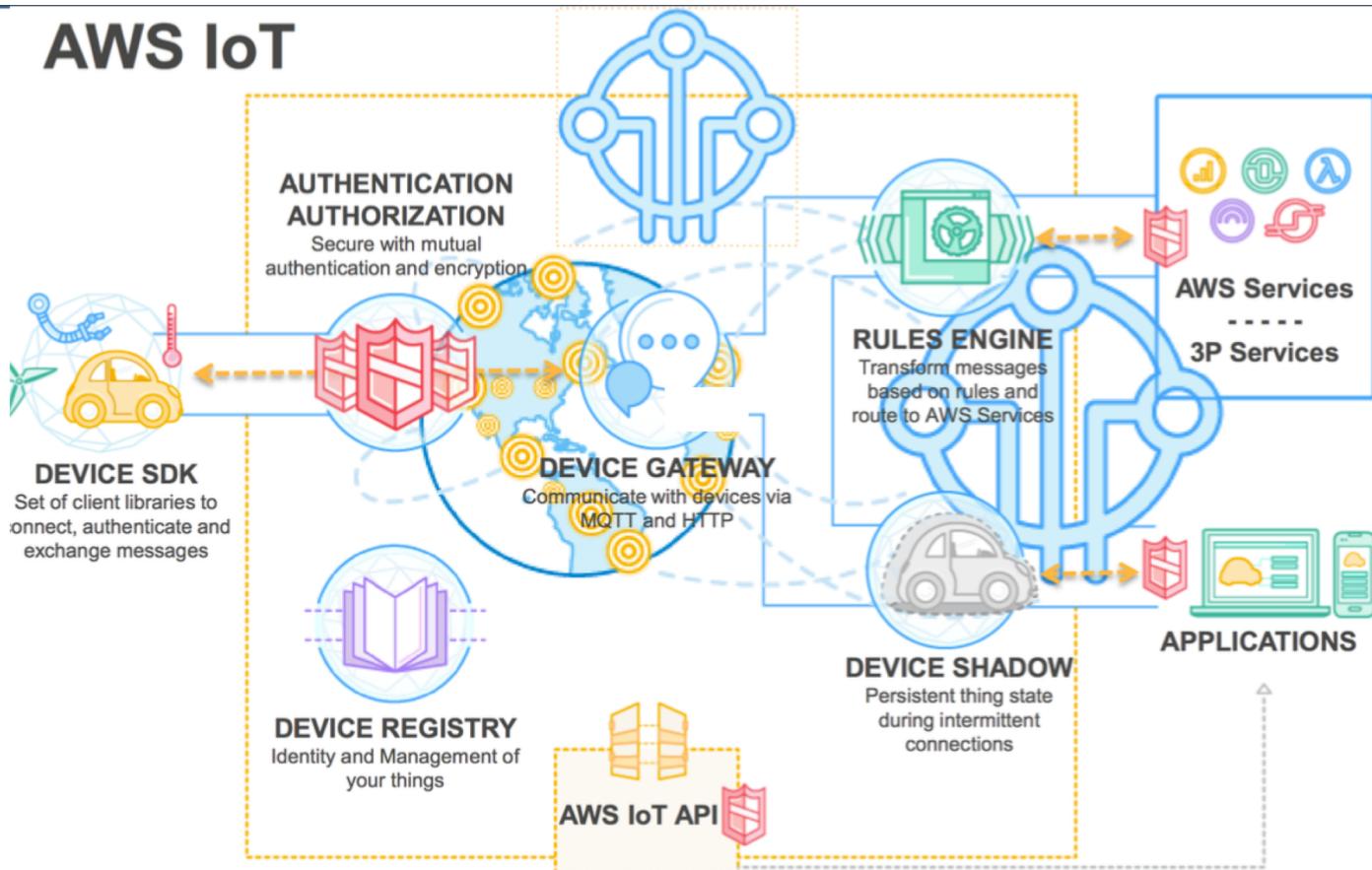
- ModBus TCP – Common
- OPC - Common for industrial assets
- HTTP – JSON over HTTP
- MQTT - Consumer oriented, promising

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



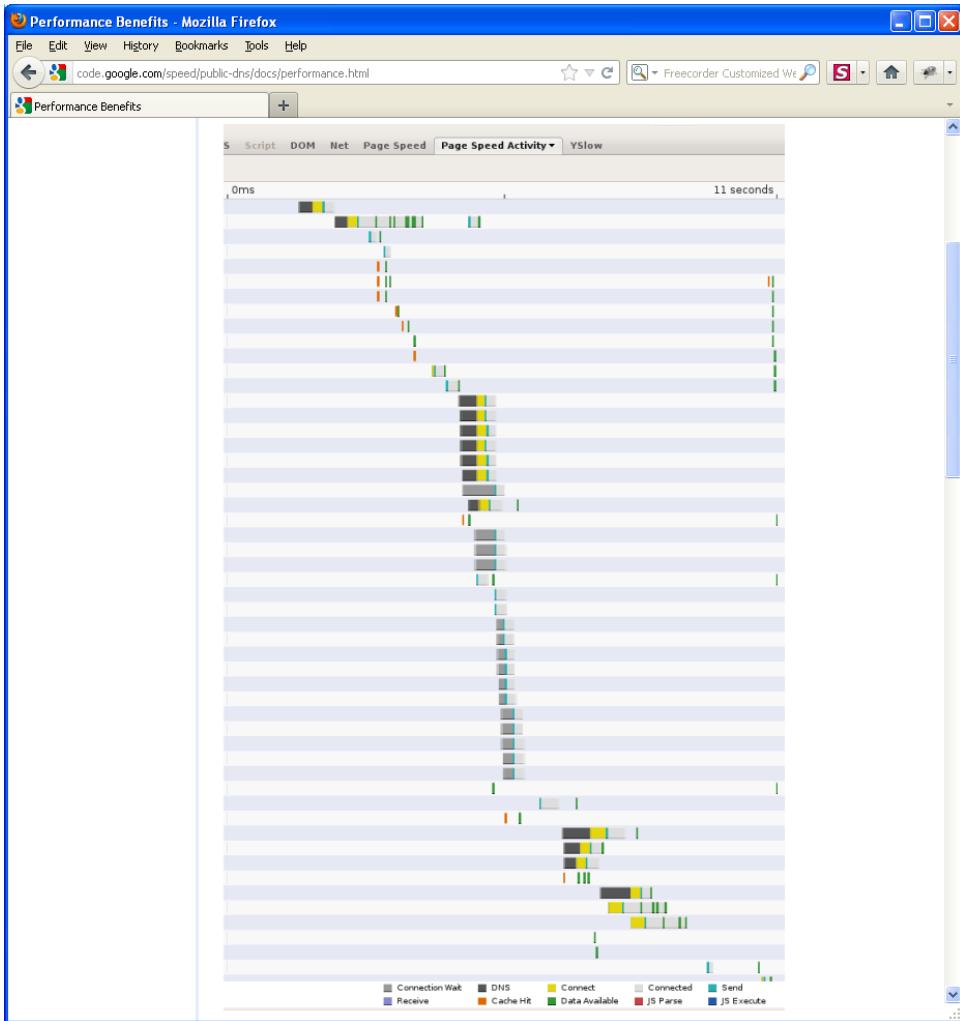
Domain Name System

- 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, January 2017,
at <http://ftp.isc.org/www/survey/reports/2017/01/bynum.txt>

Domain	Hosts = All Hosts	- Dup Names	Level 2 Domains	Level 3 Domains	Marco
TOTAL	1062660523	1140409408	77748885	5008607	13278000
net	384830238	394172298	9342060	379372	68169654 Networks
com	166862000	200000000	33600000	28550000	25666002 Commercial
jp	70245604	78408638	160034	62393	1247769 Japan
de	47734376	47892422	158046	183821	2886237 Germany
br	45470911	46163801	928990	570	272414 Brazil
it	28210729	28270273	59544	42279	709637 Italy
fr	22546842	22670251	123409	43736	678553 France
mx	18139711	19507480	1367769	2302	121693 Mexico
cn	17489282	18989869	1499687	7493	21595 China
au	17074789	17282404	207615	78	86330 Australia
ar	14621340	14850539	229199	43	15264 Argentina
nl	13046954	13300973	254019	71152	3114265 Netherlands
ru	12857459	13645531	788072	102595	3490283 Russian Federation
pl	12797200	12880794	83594	26668	2163915 Poland
edu	11338886	11697477	358591	9503	3407244 Educational
ca	9781412	10142142	360323	39958	1103784 Canada
in	7452287	7984669	532382	11527	89422 India
tw	6702629	6772134	69505	1530	28545 Taiwan, Province Of China
co	6683084	6995028	313935	8923	38997 Colombia
mil	6552600	6566000	29308	203	18134 US Military
uk	5958406	7044992	1086586	1251	125659 United Kingdom
za	5830781	5972763	141982	50	23676 South Africa
be	5555478	5580487	25009	23063	163097 Belgium
tr	5475223	5505421	30198	33	8606 Turkey
se	5450997	5535421	84424	16824	429008 Sweden
ch	5139045	5245550	106510	30757	1362570 Switzerland
eg	5035282	5050852	15570	32	885 Egypt
es	4779239	4813535	34296	14634	575133 Spain
fi	4594284	4621030	26746	14719	1967971 Finland
th	3866002	3879035	13033	16	4602 Thailand
no	3758535	3790451	31916	14036	306616 Norway
at	3612246	3637710	25464	28340	351365 Austria
pt	3605933	3622127	16194	7994	293048 Portugal
cl	3584466	3669913	85447	10453	67218 Chile
arpa	3521168	4545619	1024451	115	11991 Mistakes
cz	3478082	3512837	34755	26991	93850 Czech Republic
hu	3152000	3172968	13146	18317	58235 Hungary
gr	3020802	3026704	3902	9151	91615 Greece
nz	2943584	3359592	416008	292	21717 New Zealand
dk	2852671	2886646	33975	16980	106812 Denmark
il	2492652	2535234	42582	21	11991 Israel
ro	2461426	2567306	105880	27438	1870991 Romania
ua	2458783	2636996	178213	2433	133732 Ukraine
gov	2278396	3258307	979911	2297	627478 Government
org	2158628	2350329	191701	264730	1475778 Organizations
sg	2103429	2115889	12460	1189	8756 Singapore
us	1947381	2067377	119996	23242	91787 United States
id	1833812	1869227	35415	392	17834 Indonesia
unknown	1737131	14352601	12615470	348114	741634 Unknown
hr	1686850	1688913	2063	1905	22685 Croatia (local name: Hrvatska)
uy	1667566	1671739	4173	95	1940 Uruguay
lt	1603630	1608638	5008	5325	275166 Lithuania
ie	1508145	1518440	10295	9265	255805 Ireland

Top-level Domains (TLDs) Overview

For the day of December 18, 2018

TLD	New	Deleted	Transferred	Current Total
.COM	111,406	98,355	124,326	138,915,954
.NET	4,462	10,218	8,058	13,874,395
.ORG	4,859	6,041	5,629	10,291,114
.INFO	4,238	12,576	9,106	5,060,034
.BIZ	683	1,775	2,353	2,180,918
.US	1,174	1,132	946	2,038,536
TOTALS	126,822	130,097	150,418	172,360,951

Above shows 138 million .com sites out
Of a total 172 million; see
<http://www.dailychanges.com>

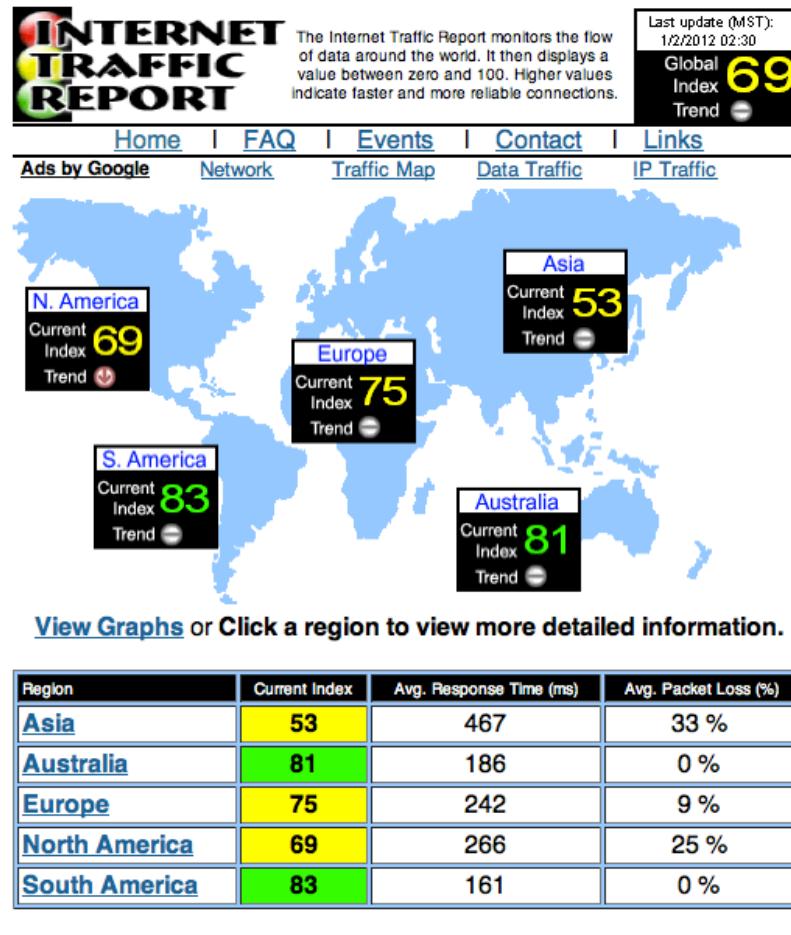
Try also:

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

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

Internet Traffic

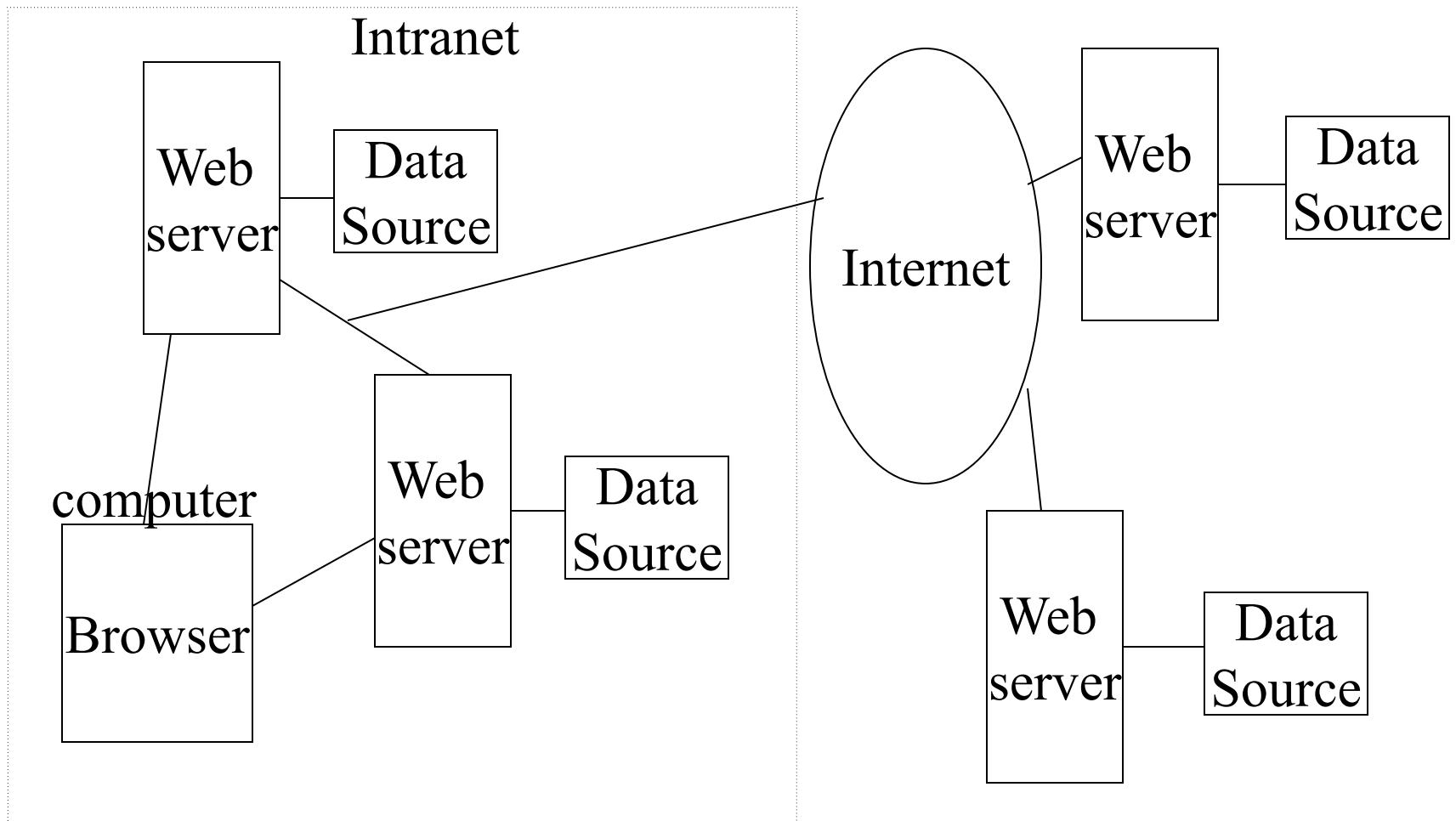
- How efficiently is the Internet working now
 - <http://www.internettrafficreport.com>



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

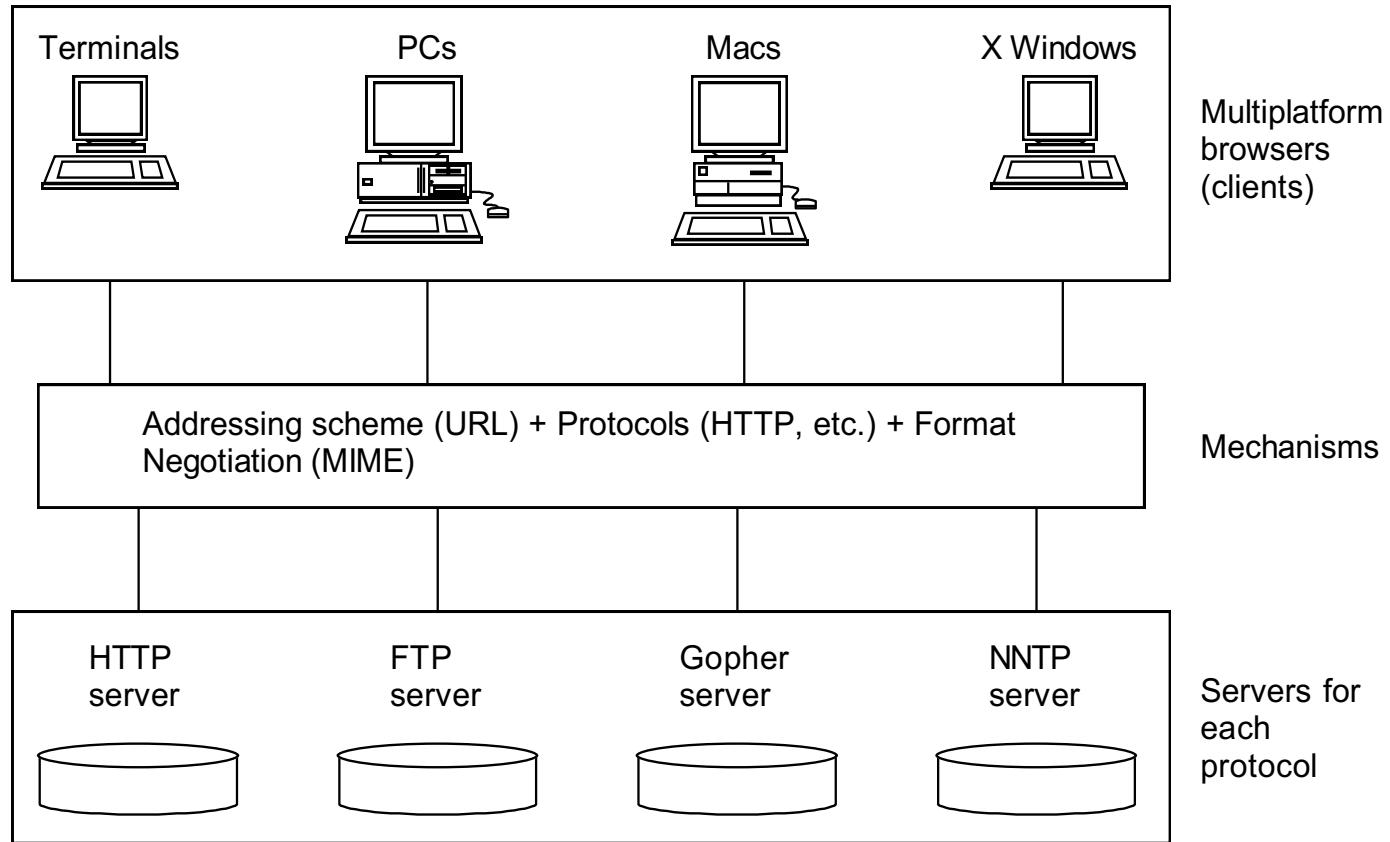
Graphical View of the WWW



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

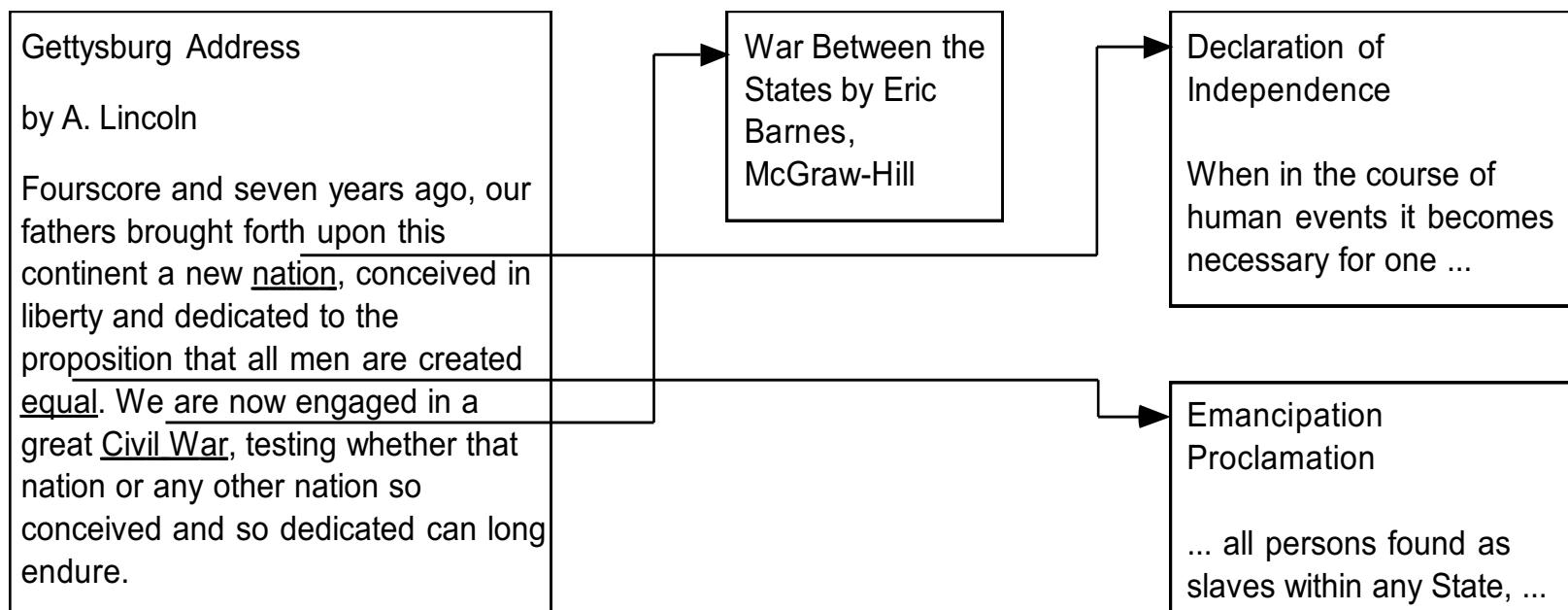
~	%7E		%7C
SPACE	%20	\	%5C
%	%25	^	%5E
&	%26	[%5B
=	%3D]	%5D
?	%3F	#	%23
{	%7B	>	%3E
}	%7D	<	%3C

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

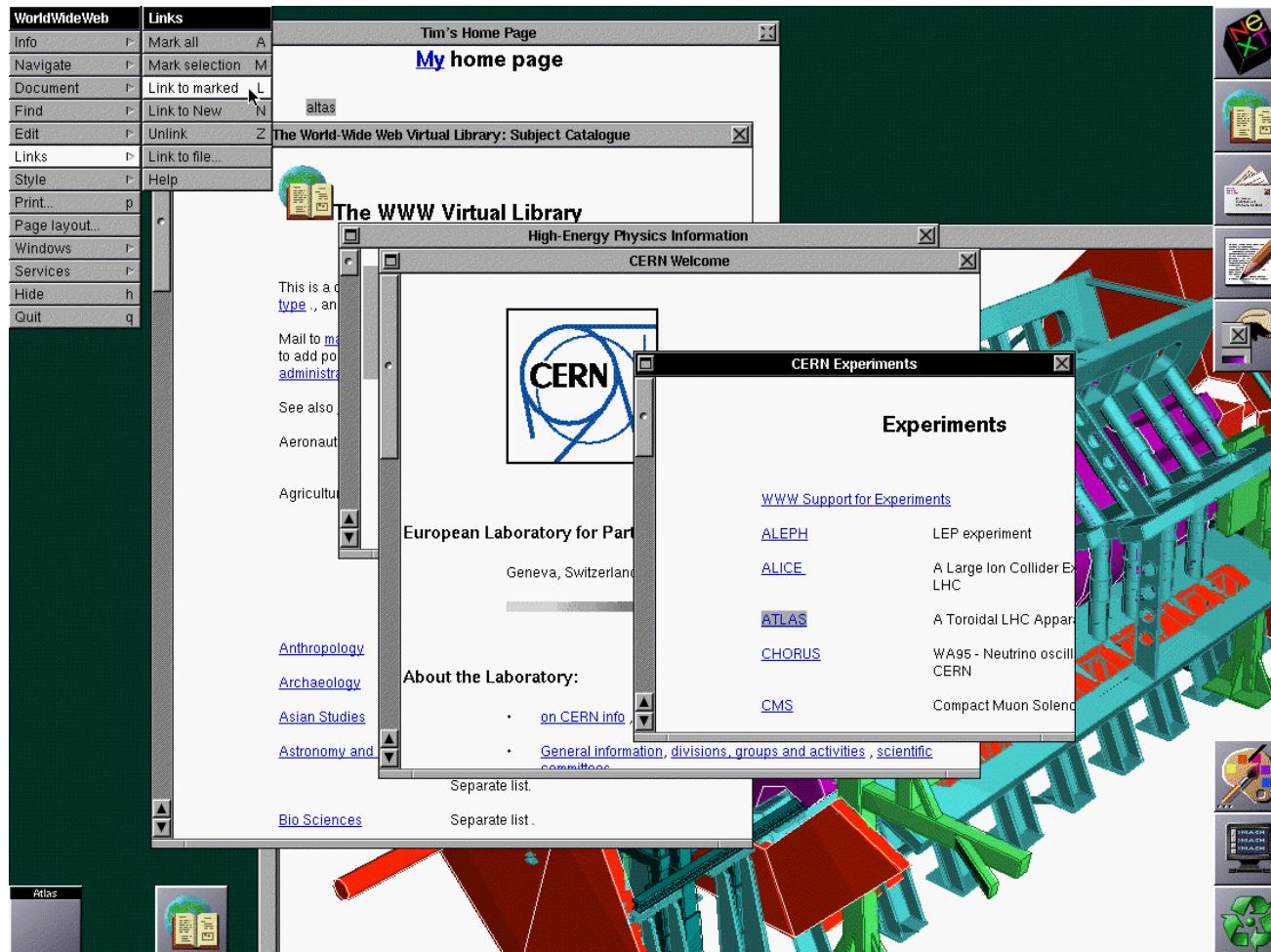


Early History of the WWW

- 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. Also known as the "Internet Bubble."
- 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>



London Olympics (July 2012)

See <http://www.zdnet.com/article/web-inventor-tim-berners-lee-stars-in-olympics-opening-ceremony/>

<https://www.youtube.com/watch?v=KW6ivwDcOY4>



Sir Tim Berners-Lee live-tweets during the 2012 Olympics opening ceremony, with a NeXT Cube by his side

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.