

Lecture

Internet Trends and Web Basics

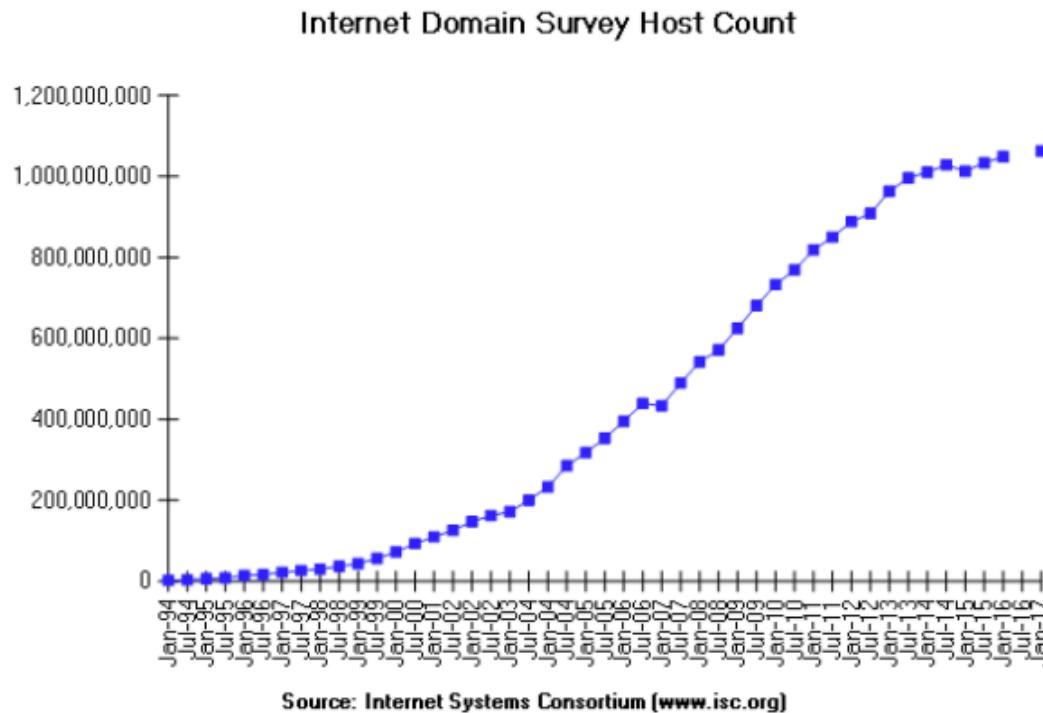
The Internet and the WWW are Different

- 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
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	



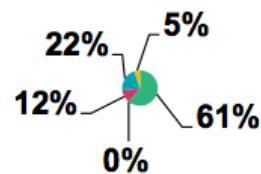
Source: United Nations / International Telecommunications Union, US Census Bureau. Internet user data is as of mid-year. Internet user data for: China from CNNIC, India from IAMAI, Iran from Islamic Republic News Agency, citing data released by the National Internet Development Center, Indonesia from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

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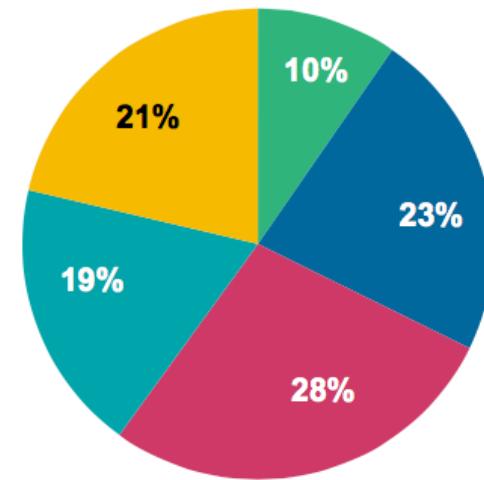
The following slides are based upon a presentation by Mary Meeker of Kleiner Perkins Caufield and Byers, see <http://www.kpcb.com/insights/2014-internet-trends> and <http://www.kpcb.com/insights/2015-internet-trends>, <http://www.kpcb.com/internet-trends>

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

1995
35MM+ Internet Users
0.6% Population Penetration

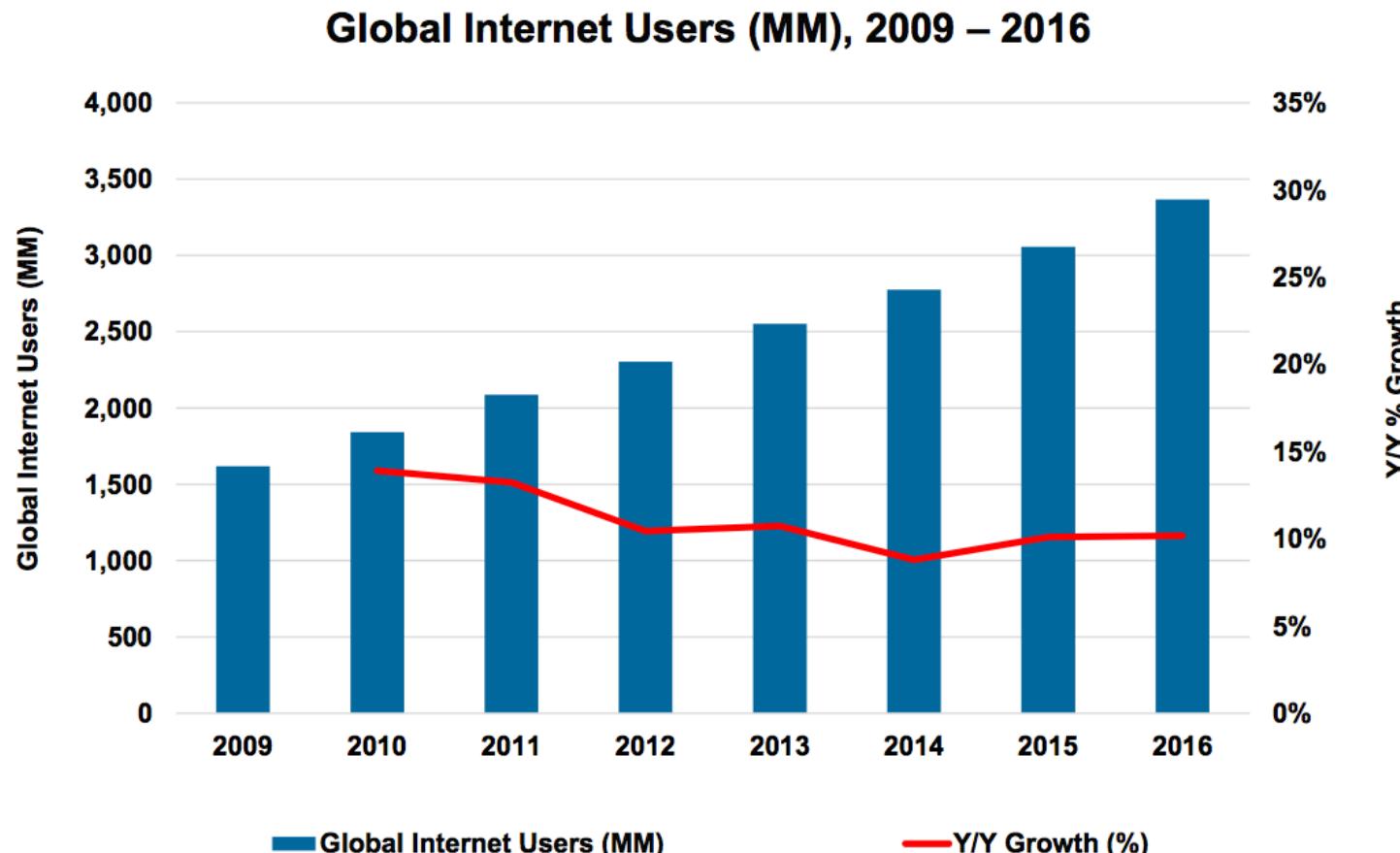


2014
2.8B Internet Users
39% Population Penetration



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

Global Internet Users = 3.4B @ 46% Penetration...
 +10% Y/Y vs. +10%...+8% Y/Y vs. +8% (Ex-India)



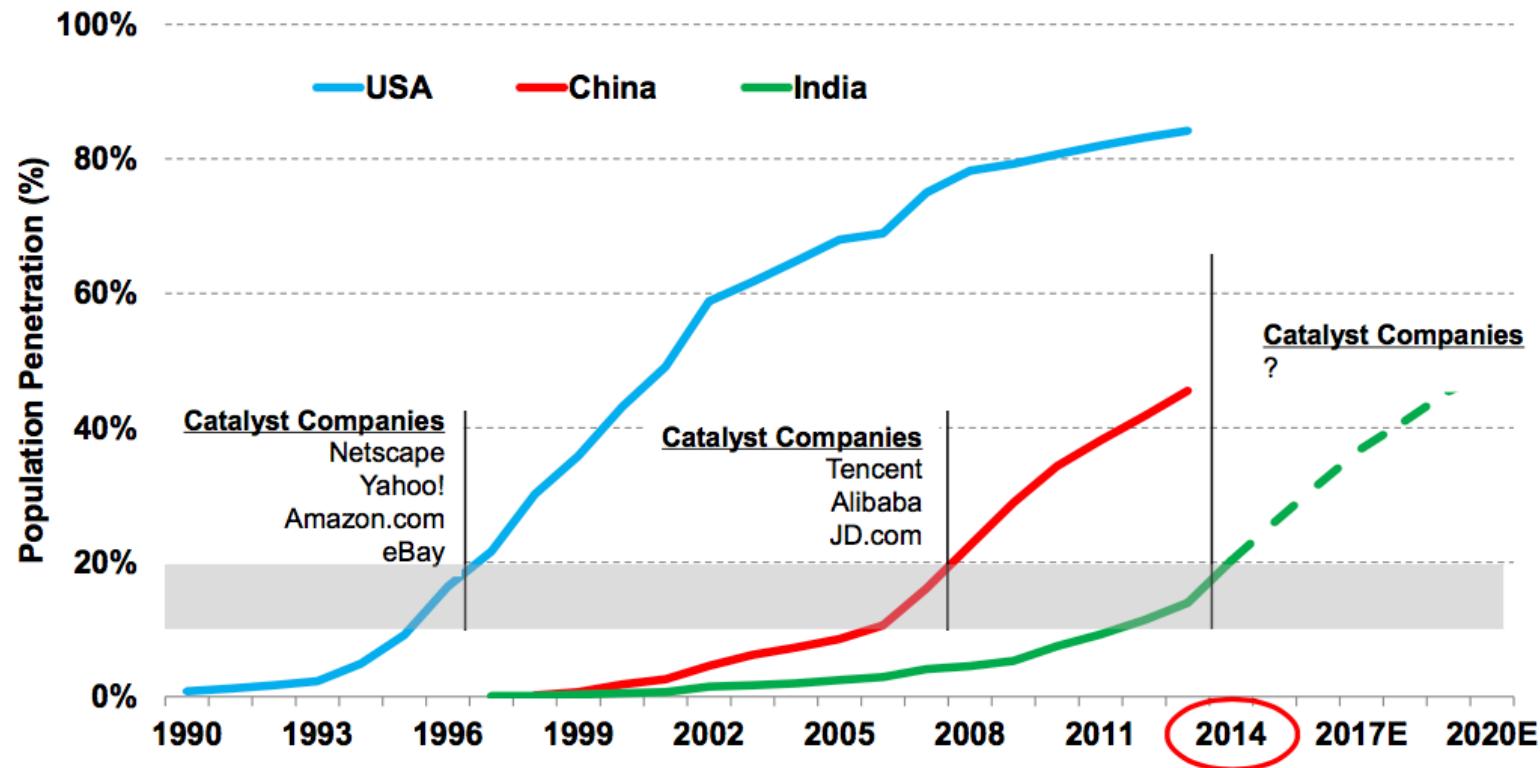
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Source: United Nations / International Telecommunications Union, US Census Bureau. Internet user data is as of mid-year. Internet user data for: USA from Pew Research, China from CNNIC, Iran from Islamic Republic News Agency / InternetWorldStats / KPCB estimates, India from KPCB estimates based on IMAI data, Indonesia from APJII.

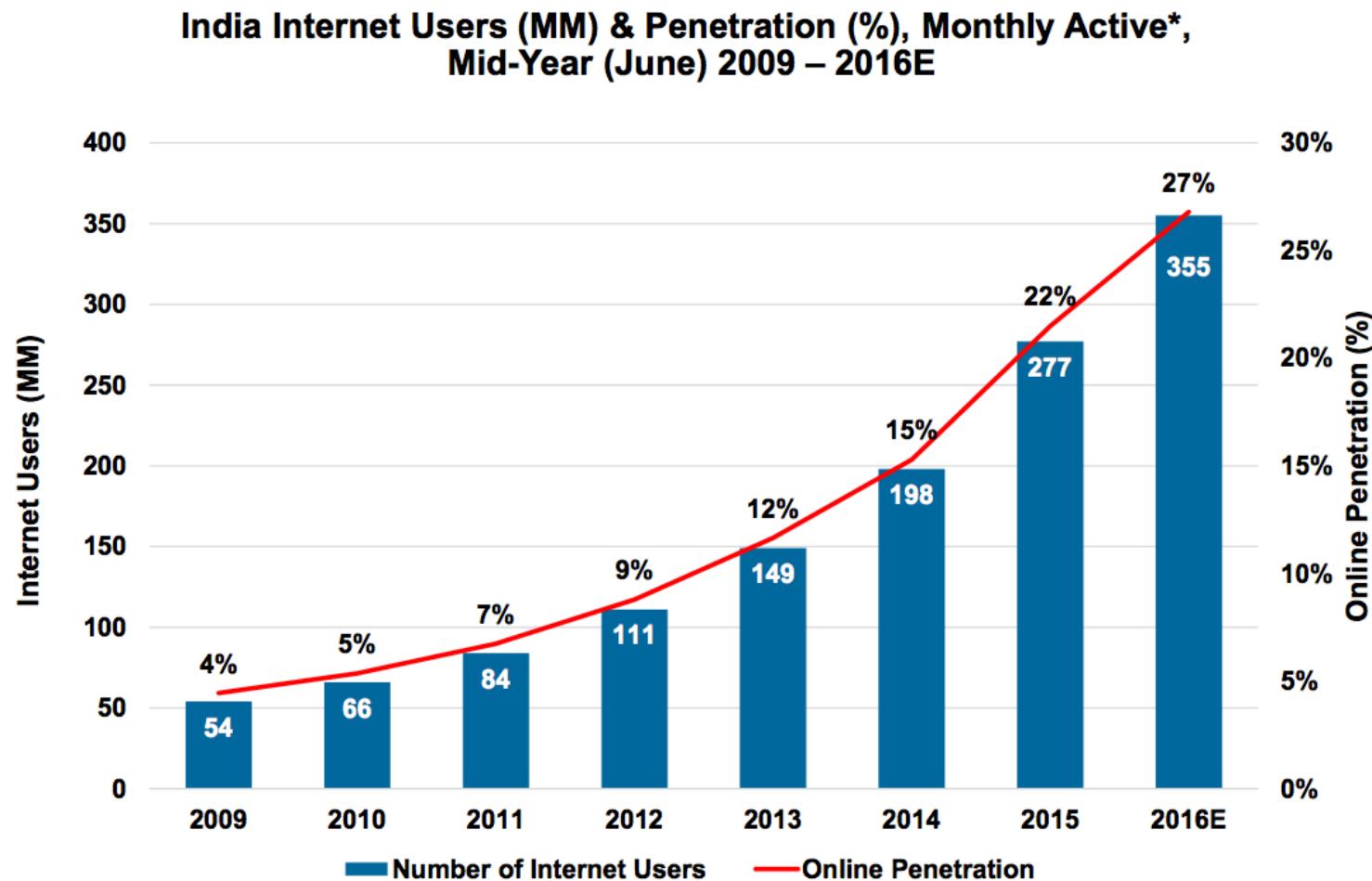
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India = Appears to Be @ Internet Penetration Growth Inflection

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



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.

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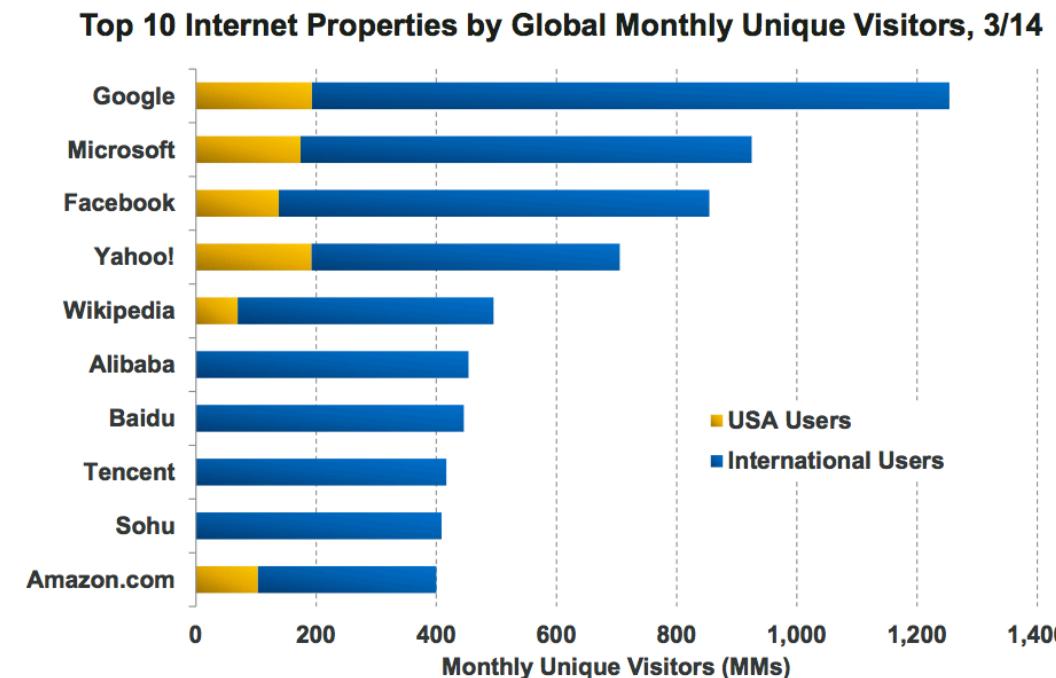
The US leads in the development of highly popular Internet websites;

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

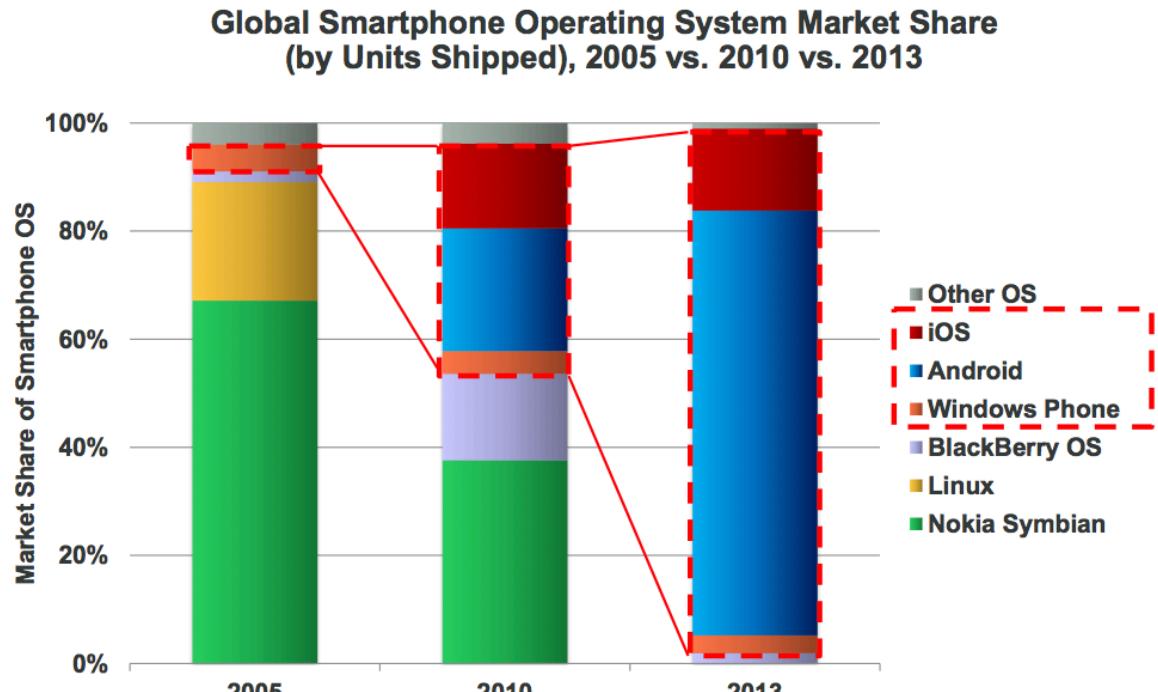


@KPCB Source: comScore, 3/14.

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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



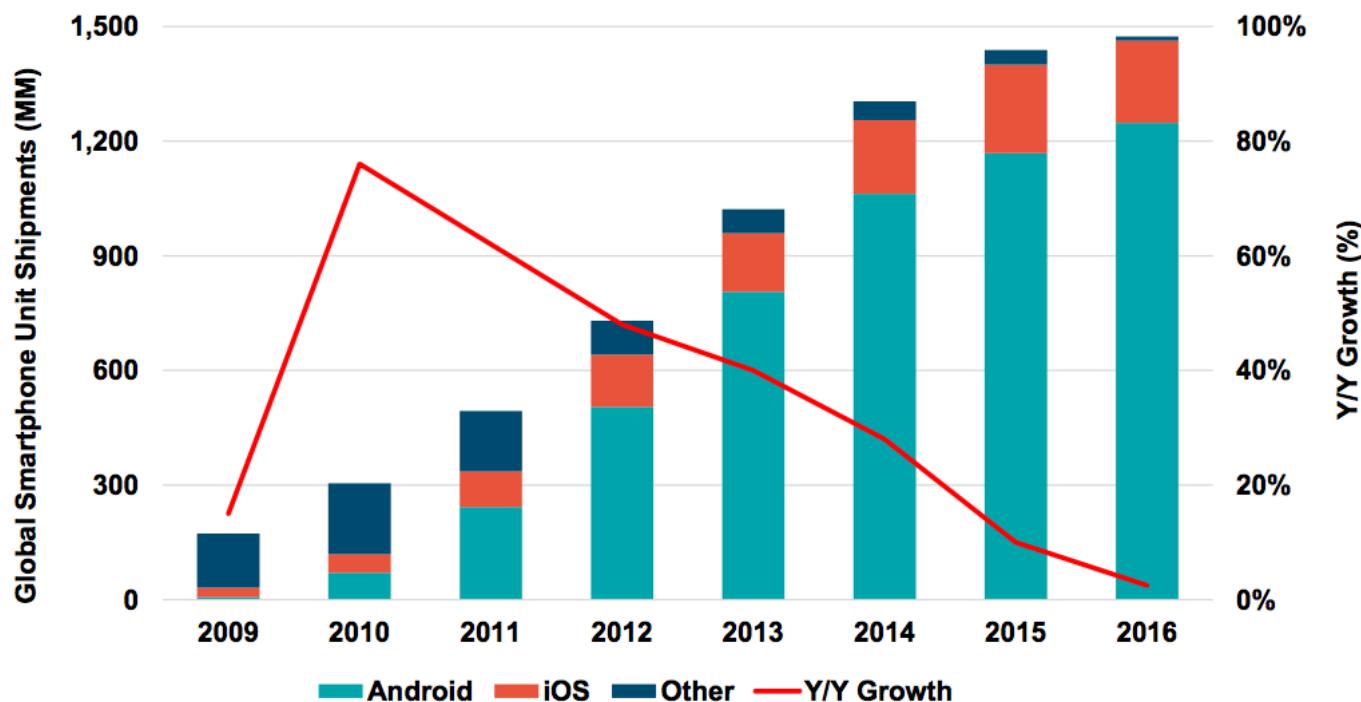
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Source: 2005 & 2010 data per Gartner, 2013 data per IDC.

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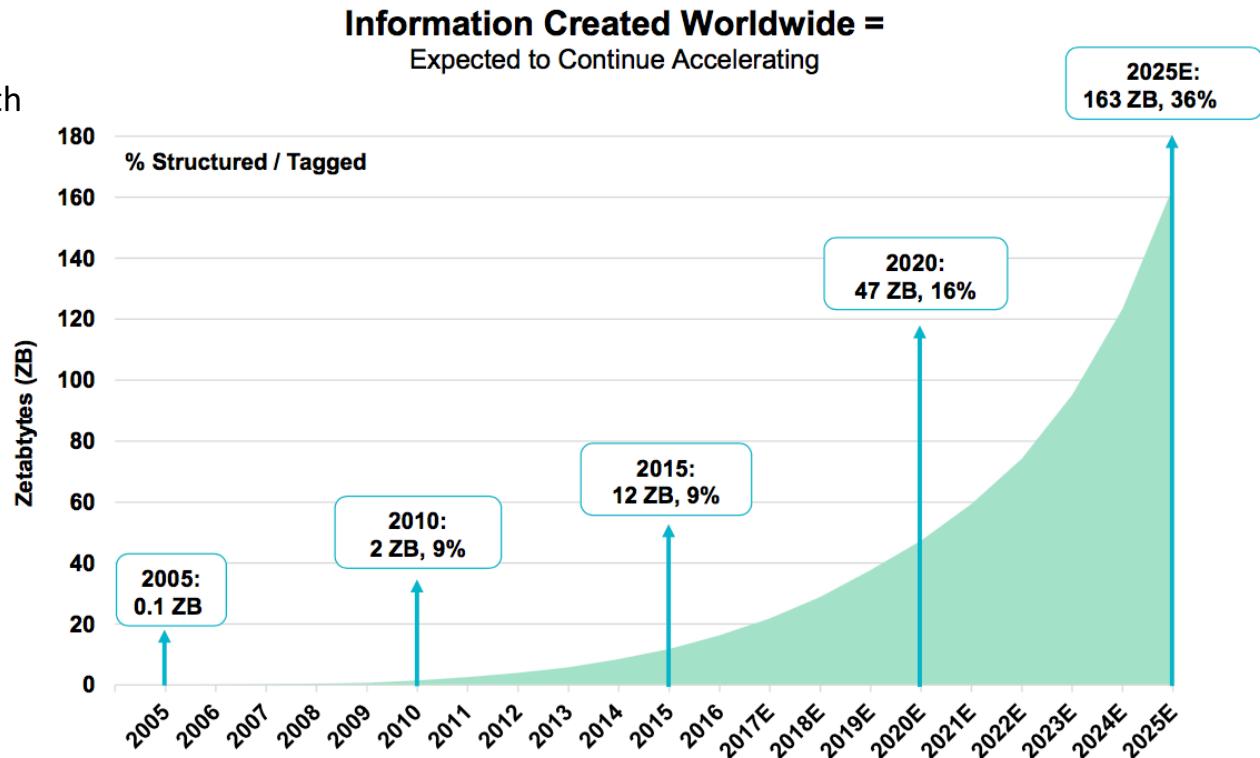
Global Smartphone Unit Shipments = Continue to Slow... @ +3% Y/Y vs. +10% (2015) / +28% (2014)

Smartphone Unit Shipments by Operating System (MM), Global, 2009 – 2016



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



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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

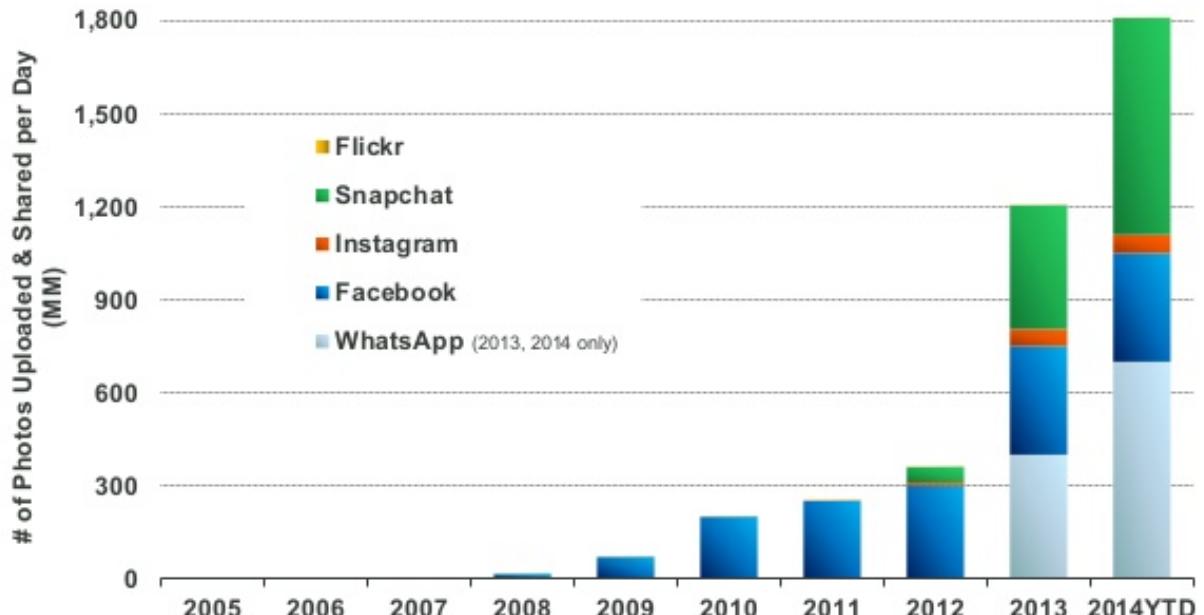
Instagram was recently (2010) purchased by Facebook for \$1 billion

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



bobby Murphy - Evan Spiegel

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



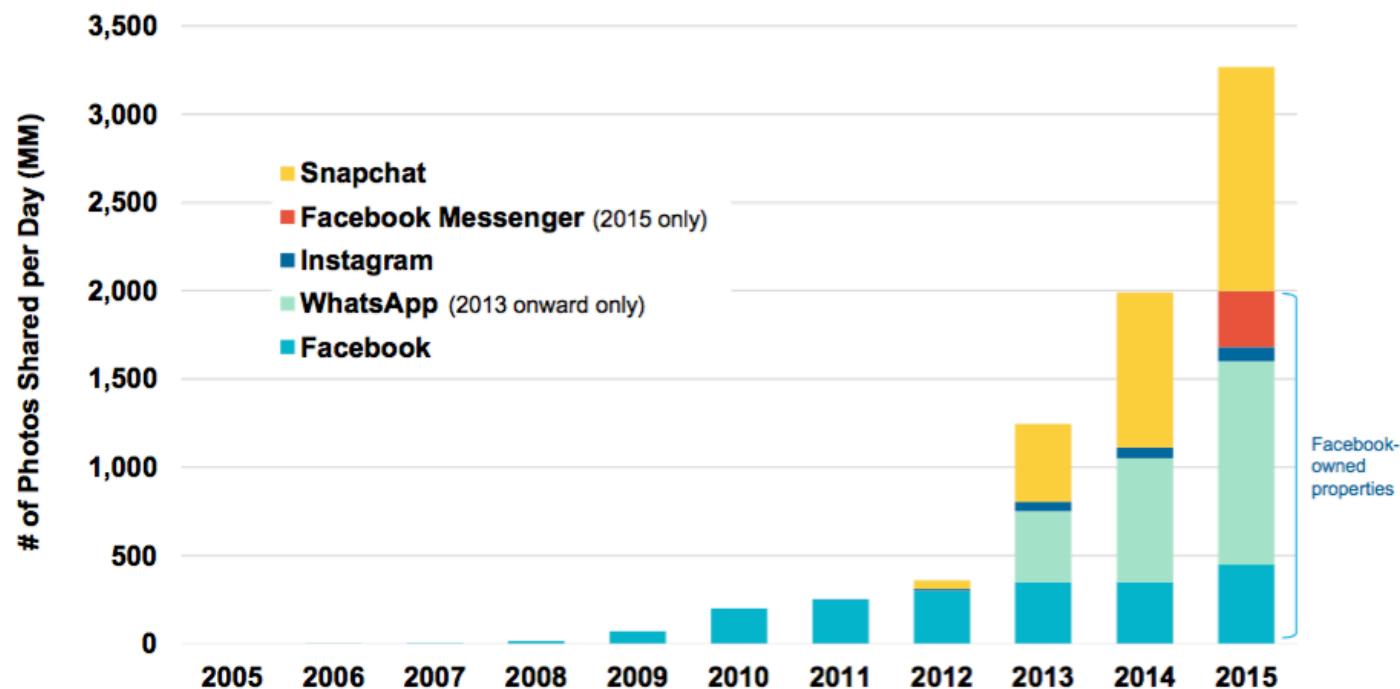
Source: KPCB estimates based on publicly disclosed company data. 2014 YTD data per latest as of 5/14.

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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

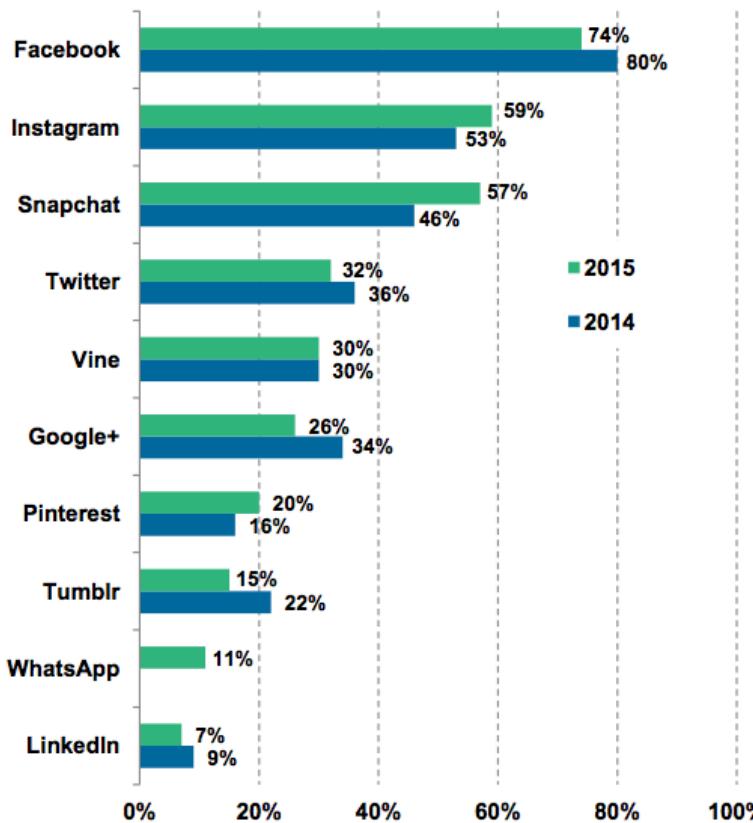
Note: Snapchat data includes images and video. Snapchat stories are a compilation of images and video. WhatsApp data estimated based on average of photos shared disclosed in Q1:15 and Q1:16. Instagram data per Instagram press release. Messenger data per Facebook (~9.5B photos per month). Facebook shares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

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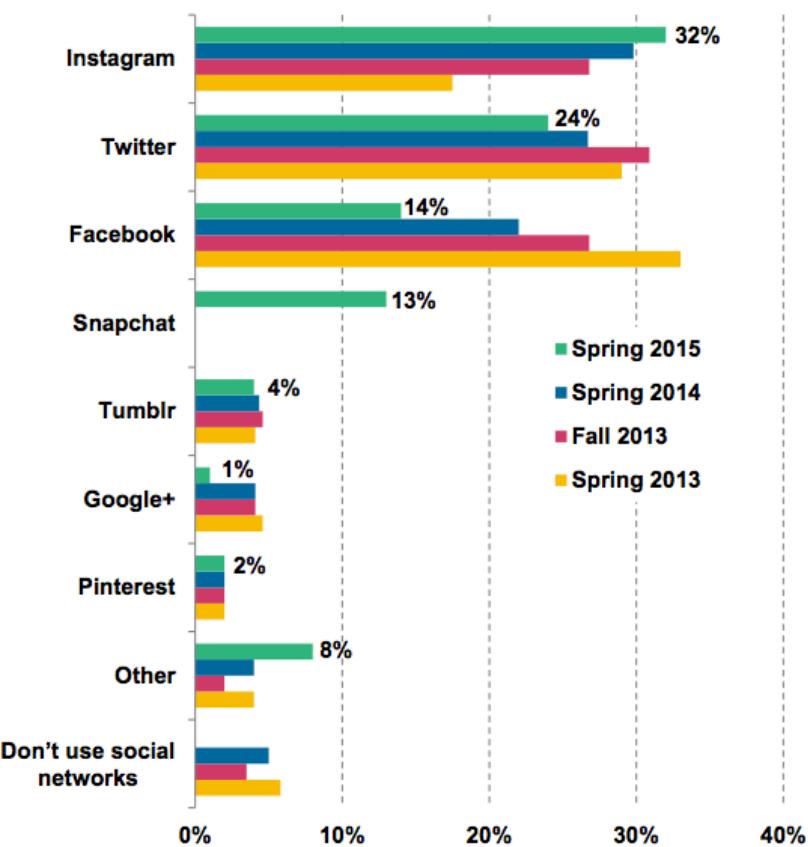
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12-24 Year Olds Internet Usage = Visual Stuff (In & Out) Rules... Instagram + Snapchat + Pinterest = Continue to Rise

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

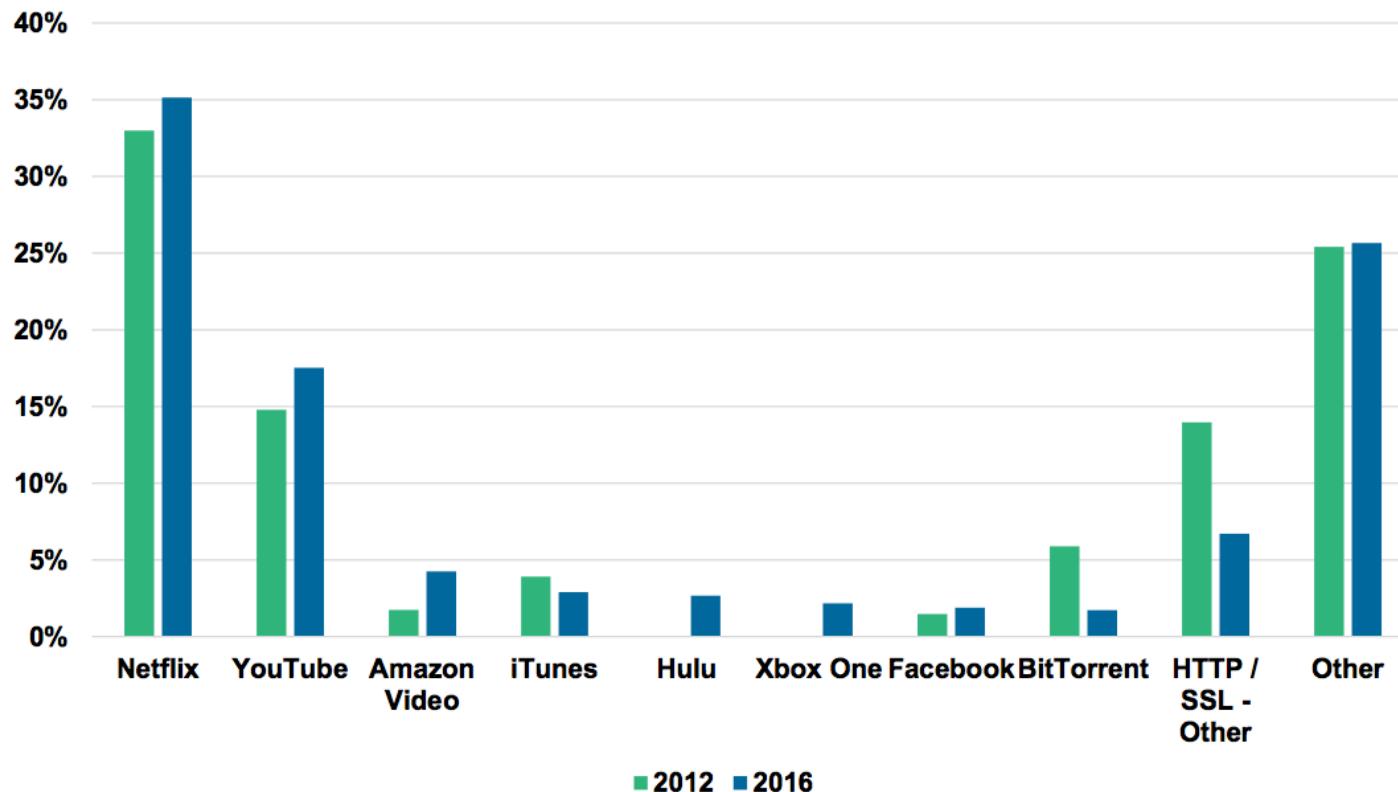


Teens' Most Important Social Network², USA, 4/15



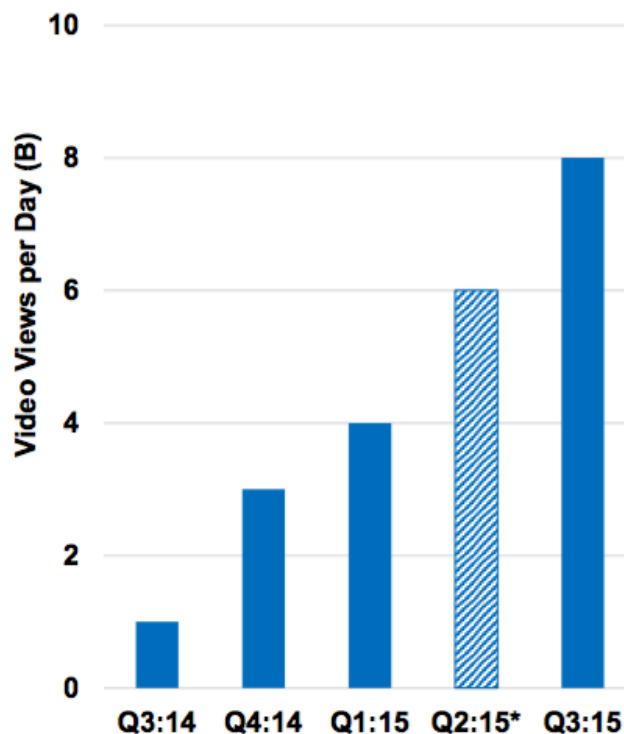
Netflix / YouTube = Fixed-Access Video Traffic Share Leaders

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

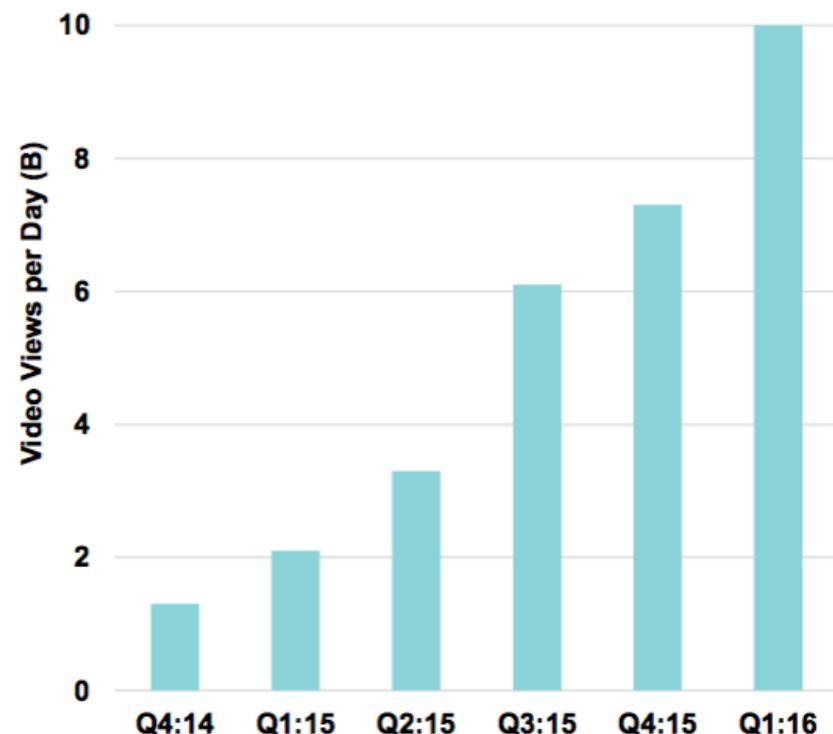


User-Shared Video Views on Snapchat & Facebook = Growing Fast

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



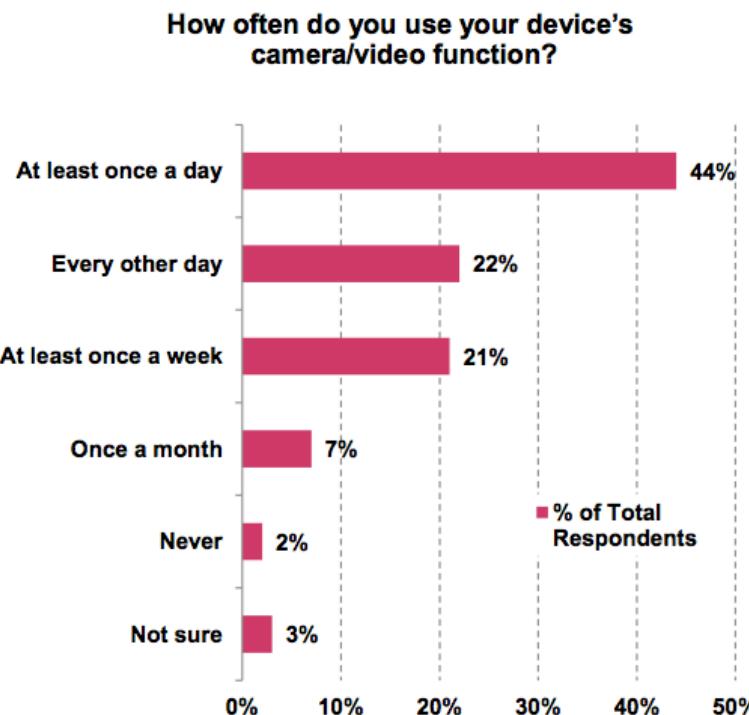
**Snapchat Daily Video Views,
Global, Q4:14 – Q1:16**



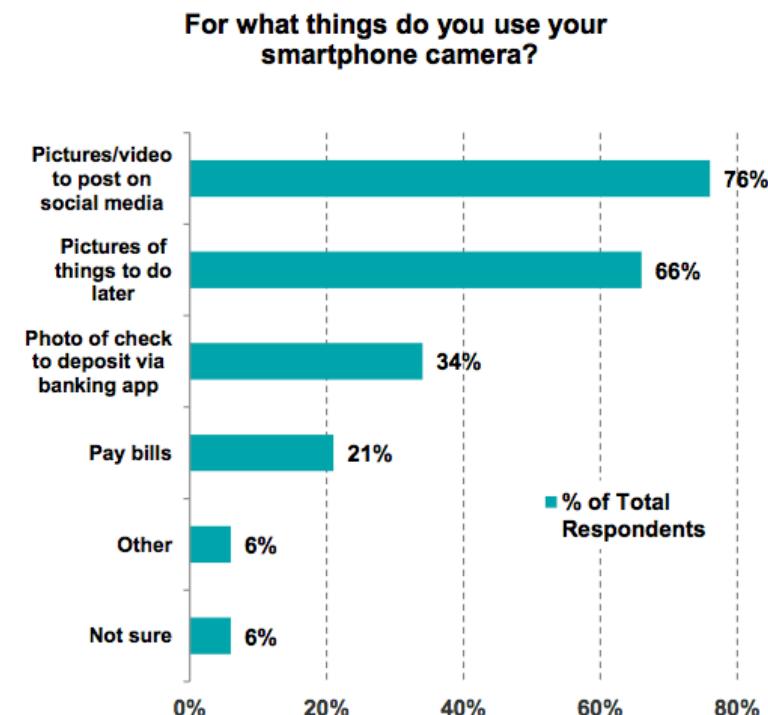
Millennials Love Their Smartphone Cameras...

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

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



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



Source: Zogby Analytics.

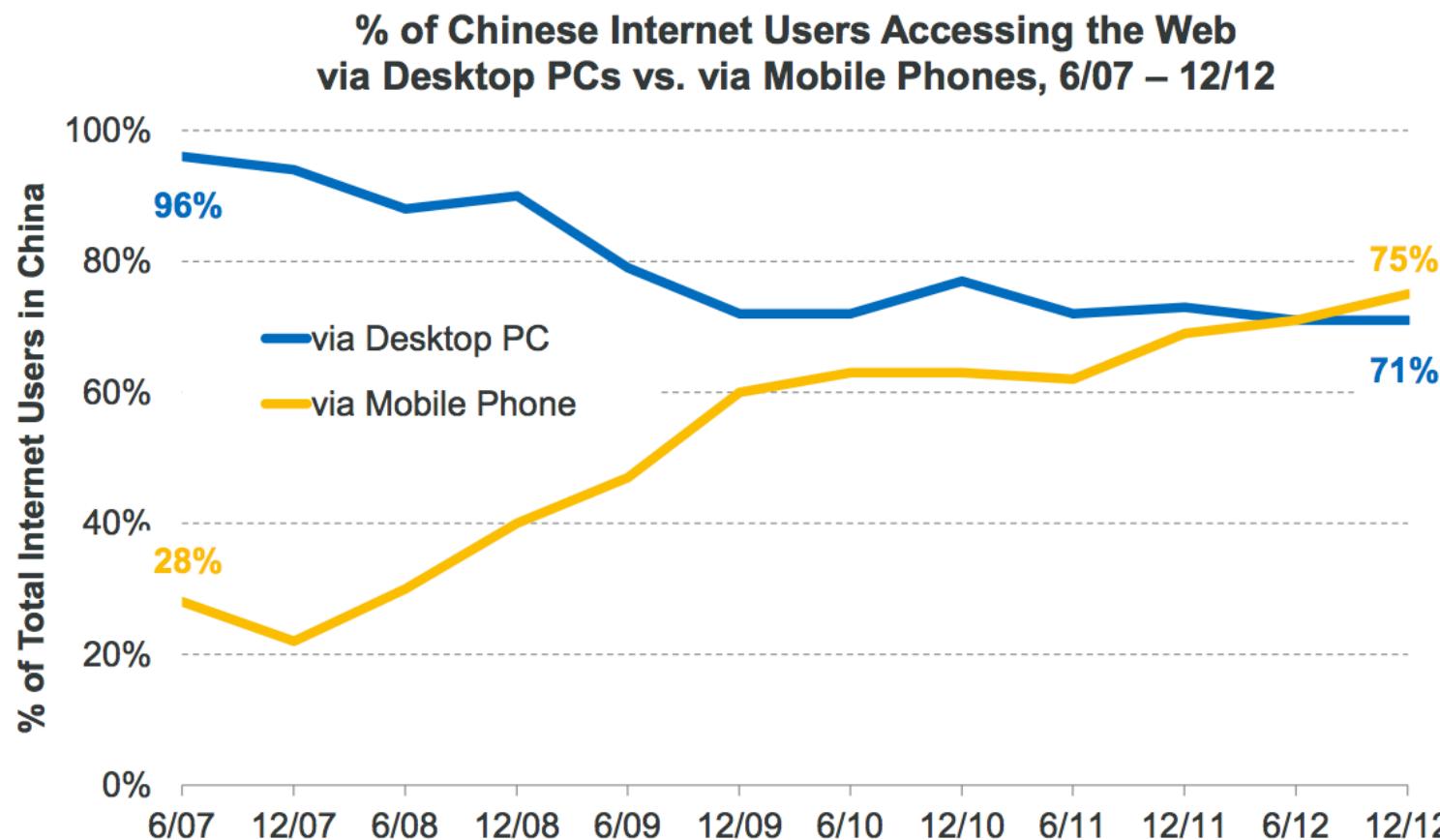
*18-24 year olds.

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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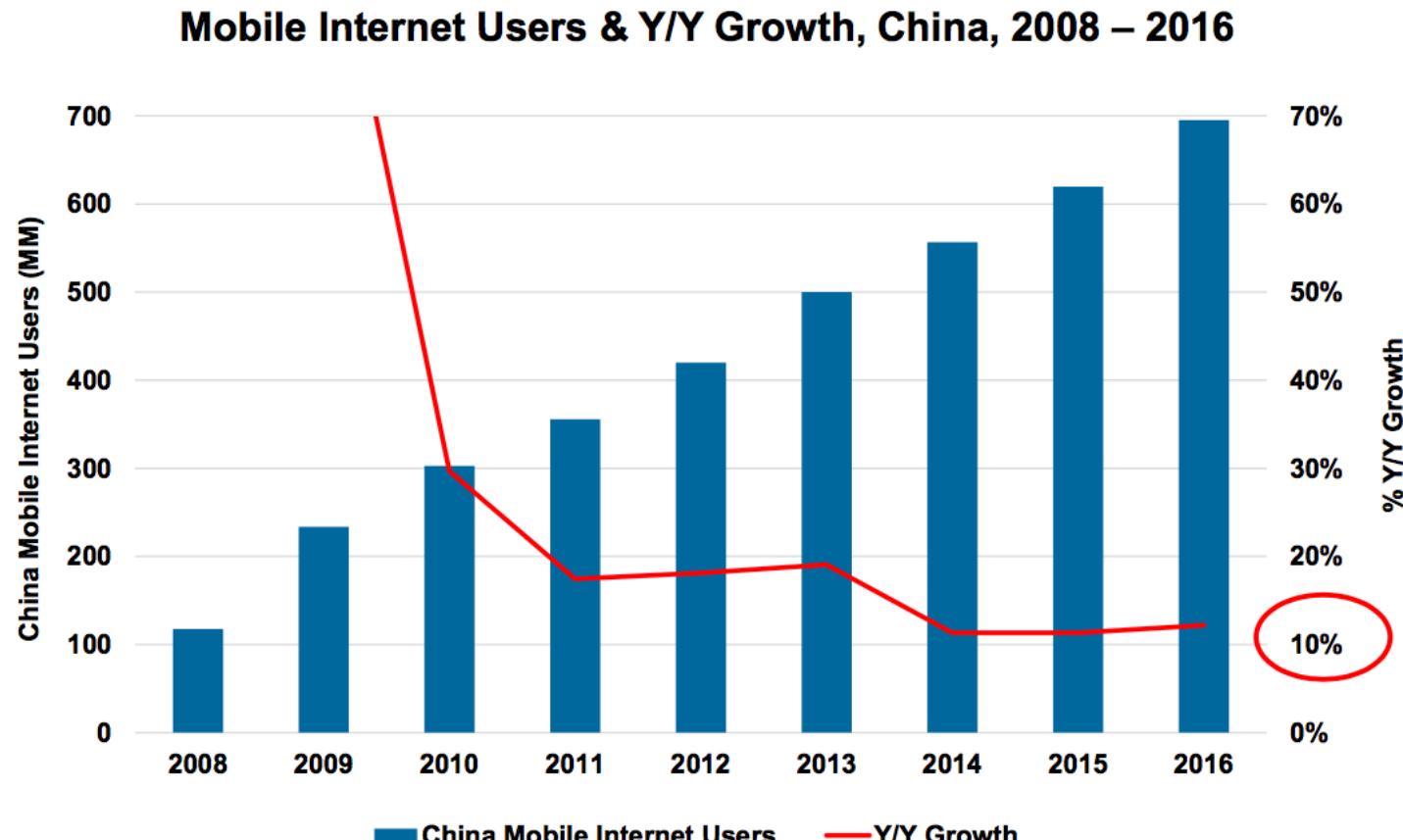
China – Mobile Internet Access Surpassed PC, Q2:12



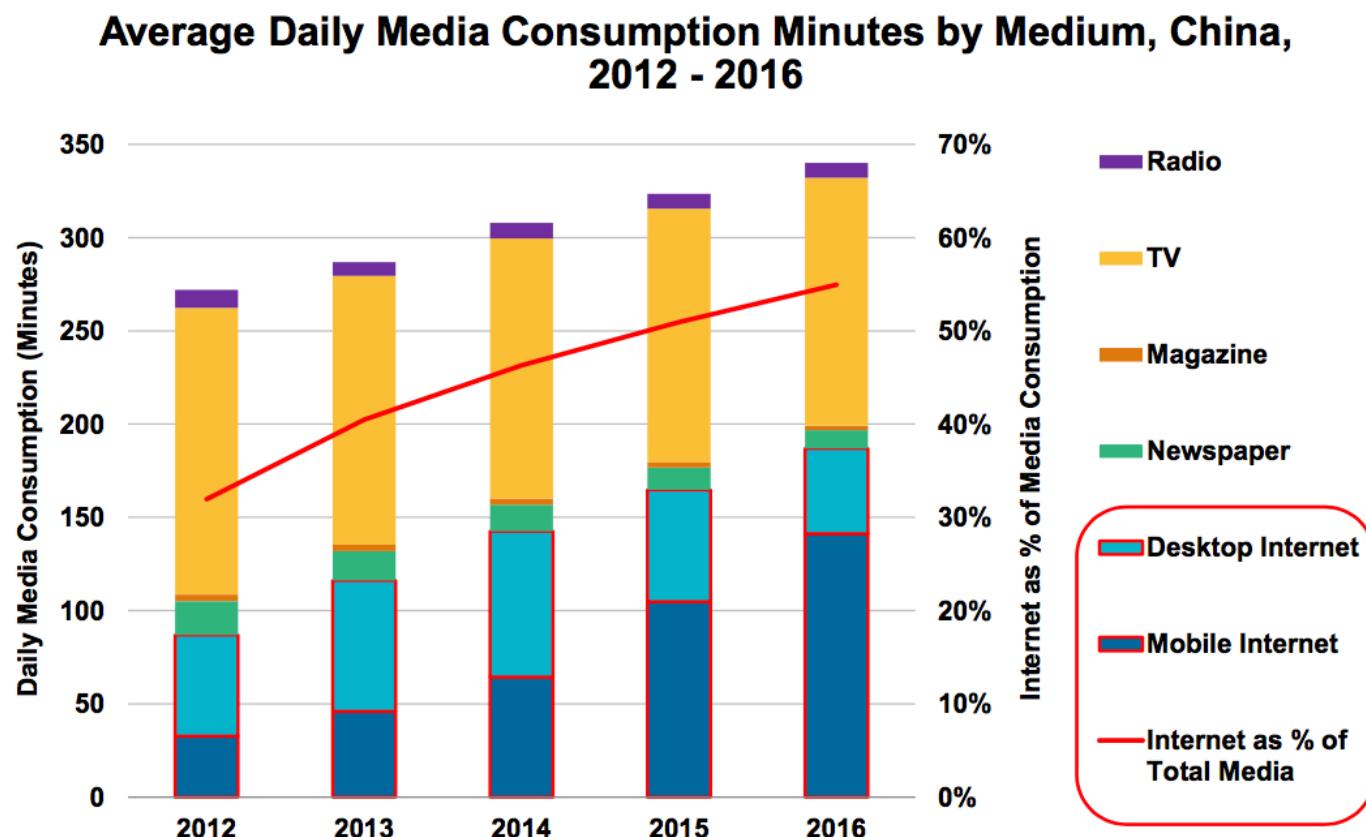
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Source: CNNIC, 1/13. 33

China Mobile Internet Users = @ ~700MM, +12% Y/Y vs. 11% in 2015



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



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Source: Zenith Optimedia

HILLHOUSE
Capital

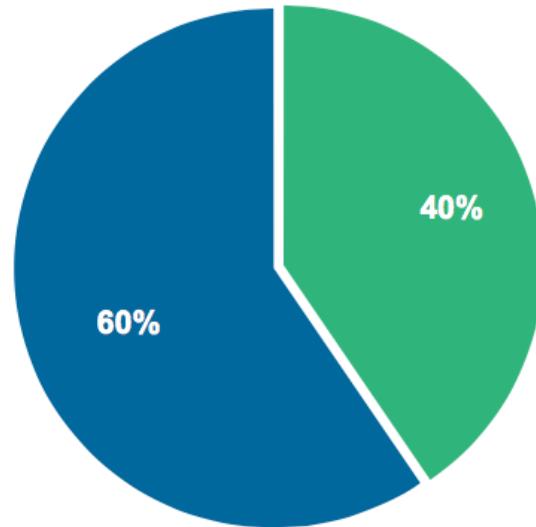
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Mobile Phone Users – 1995 → 2014... 1% to 73% Population Penetration Globally

1995
80MM+ Mobile Phone Users
1% Population Penetration



2014
5.2B Mobile Phone Users
73% Population Penetration



■ Smartphone ■ Feature Phone



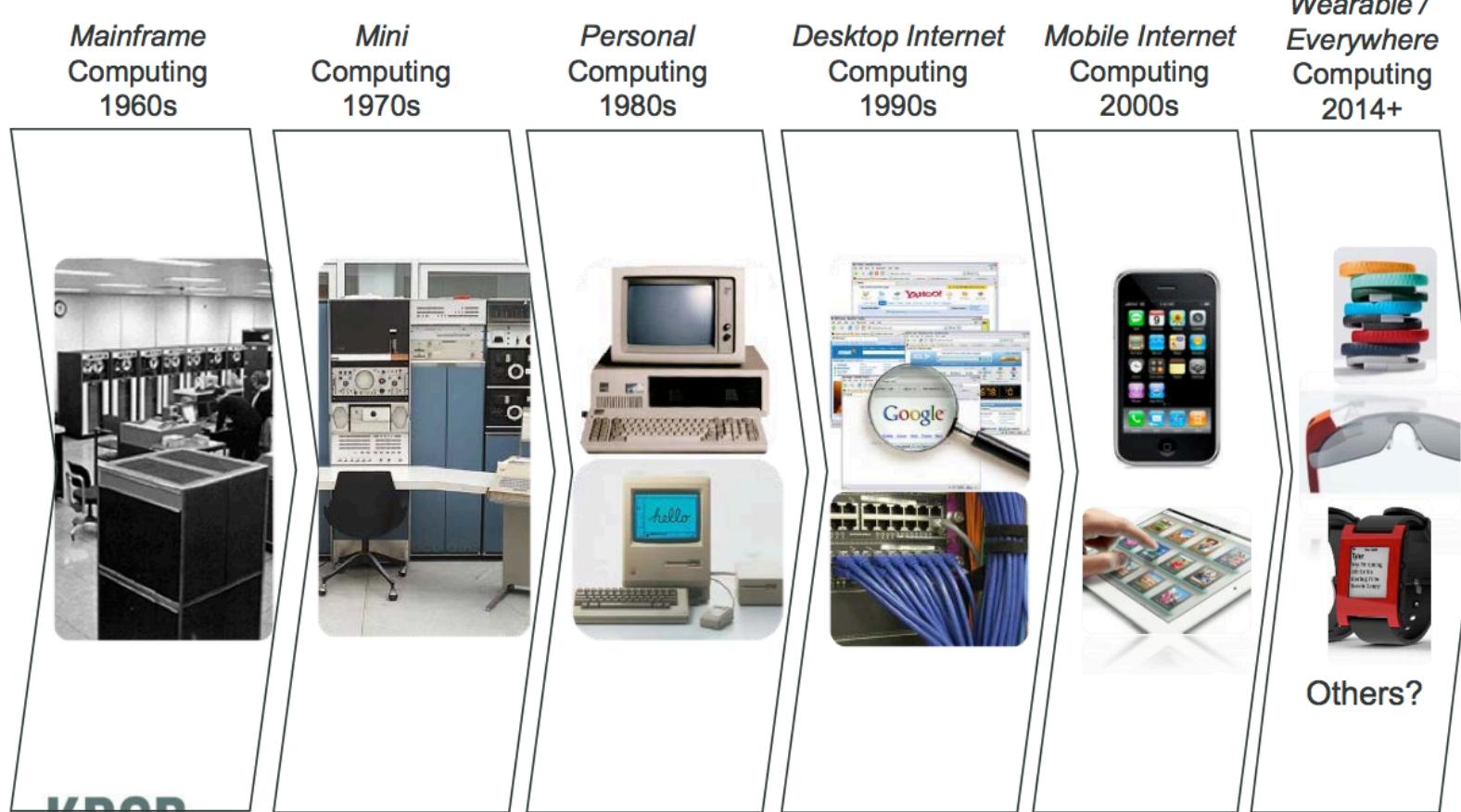
Source: Informa, World Cellular Information Service (WCIS). Assumes in 1995, one mobile phone subscription per unique user (no duplication).

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.

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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



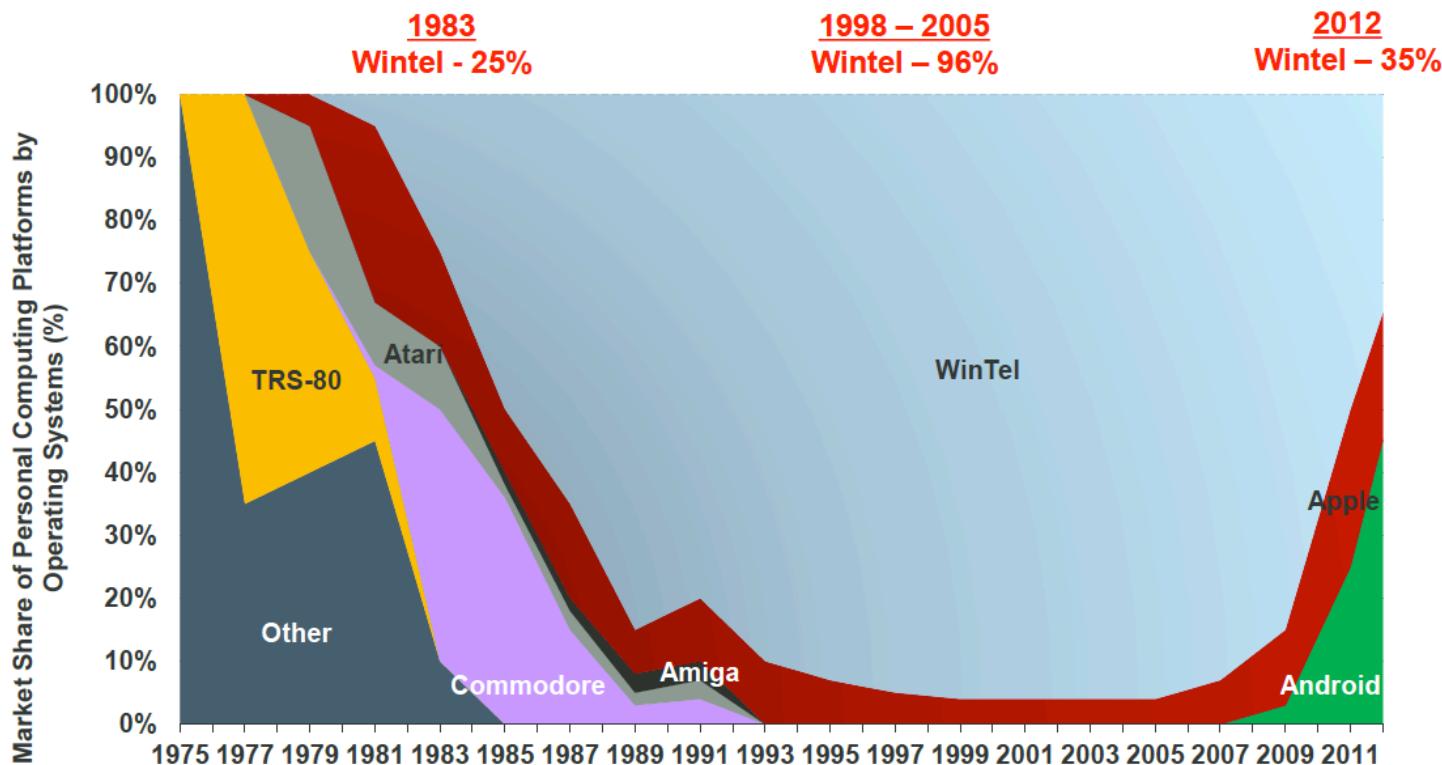
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Image Source: Computersciencelab.com, Wikipedia, IBM, Apple, Google, NTT docomo, Google, Jawbone, Pebble.

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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



...While The Cloud Rises

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

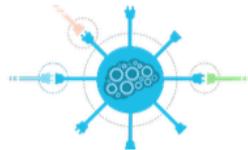


*Note: S3 is AWS' storage product and used as proxy for AWS scale / growth .
Source: Company data.



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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 =

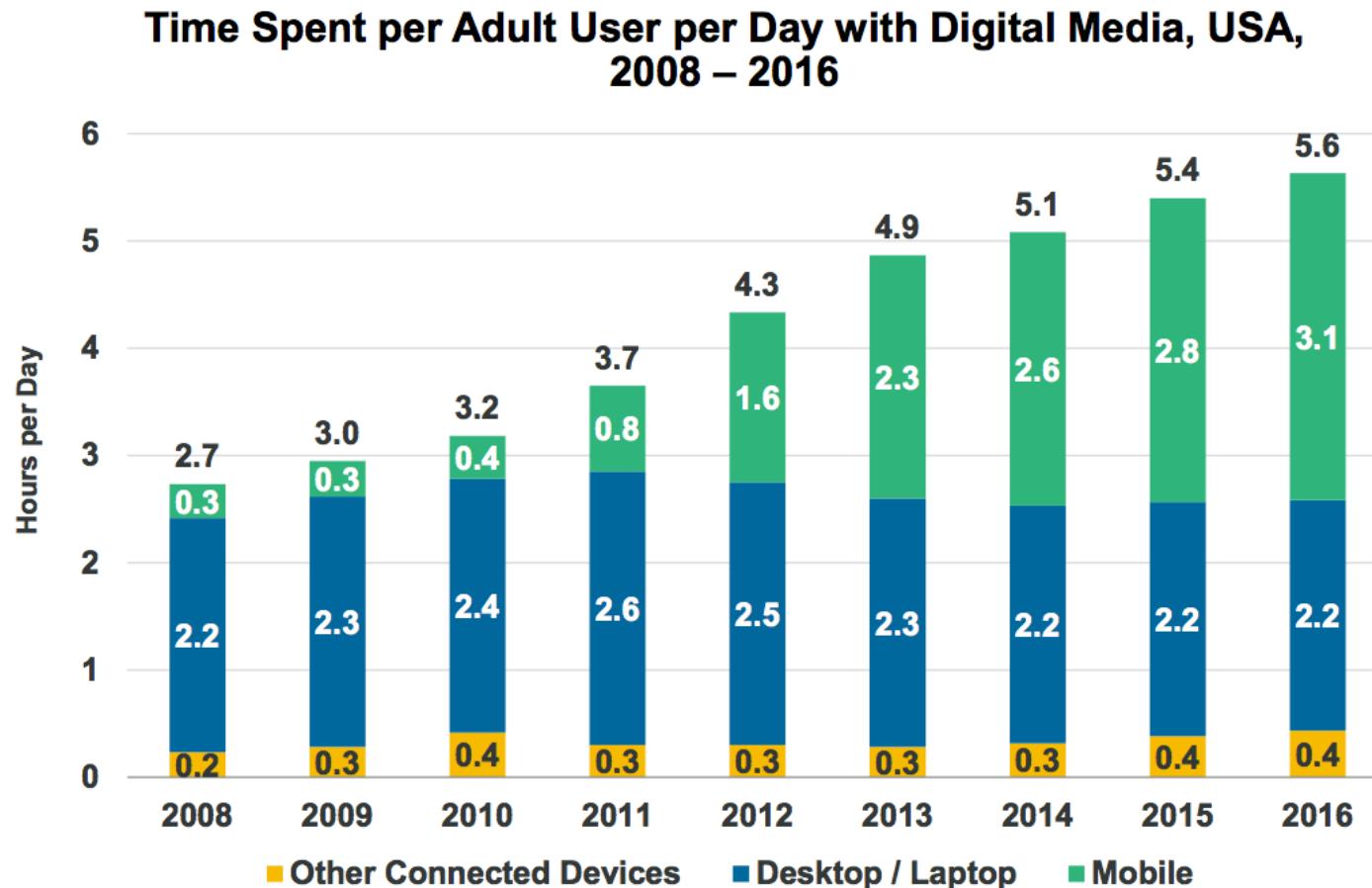
Likes of Google BigQuery / Snowflake / AWS Redshift Spectrum nearly infinitely scalable / usage based + have minimal maintenance requirements



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

Internet Usage (Engagement) = Solid Growth +4% Y/Y Mobile >3 Hours / Day per User vs. <1 Five Years Ago, USA



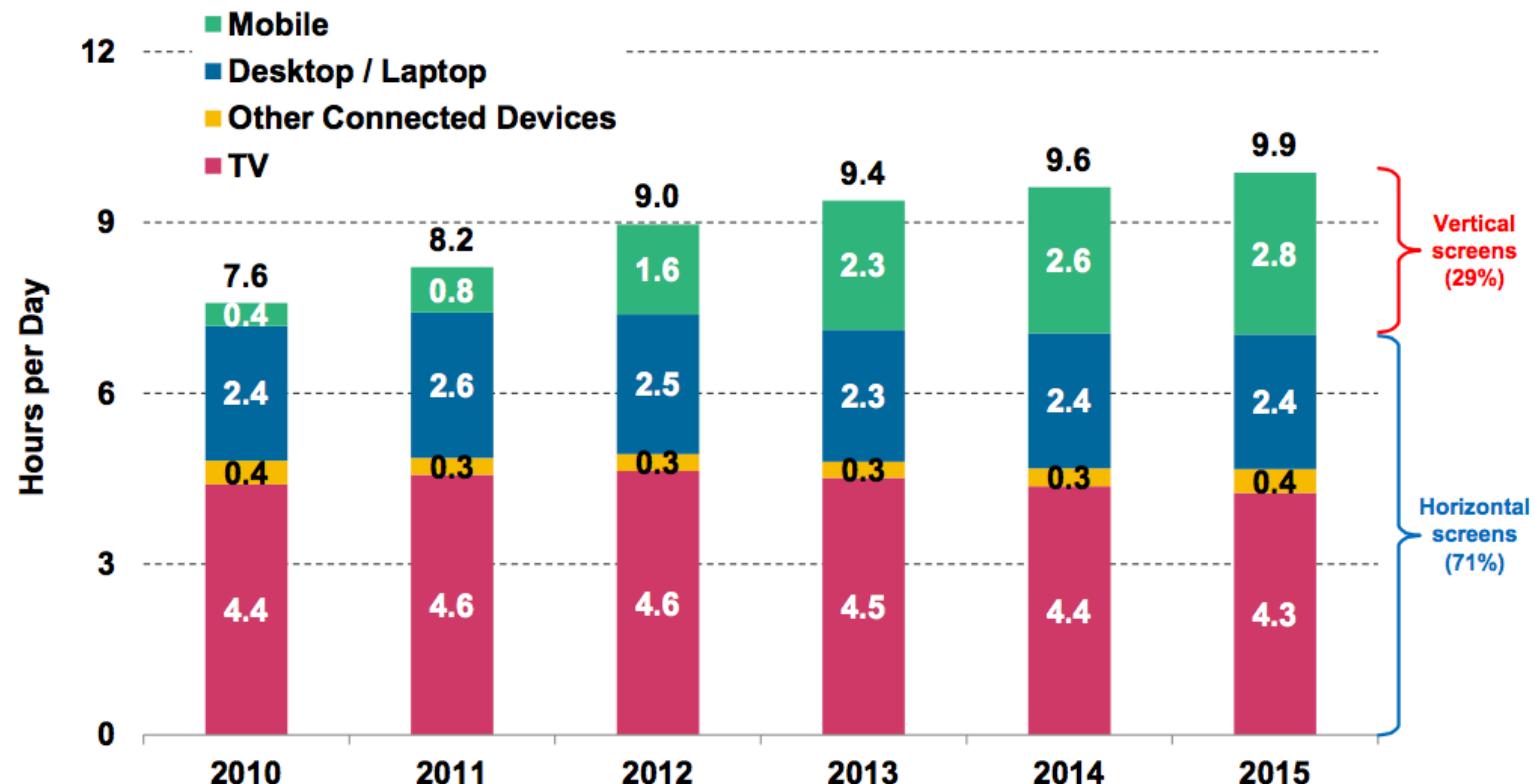
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Source: eMarketer 9/14 (2008-2010), eMarketer 4/15 (2011-2013), eMarketer 4/17 (2014-2016). Note: Other connected devices include OTT and game consoles. Mobile includes smartphone and tablet. Usage includes both home and work. Ages 18+; time spent with each medium includes all time spent with that medium, regardless of multitasking.

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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



Messaging Apps = Top Global Apps in Usage + Sessions

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

Top Apps by Usage

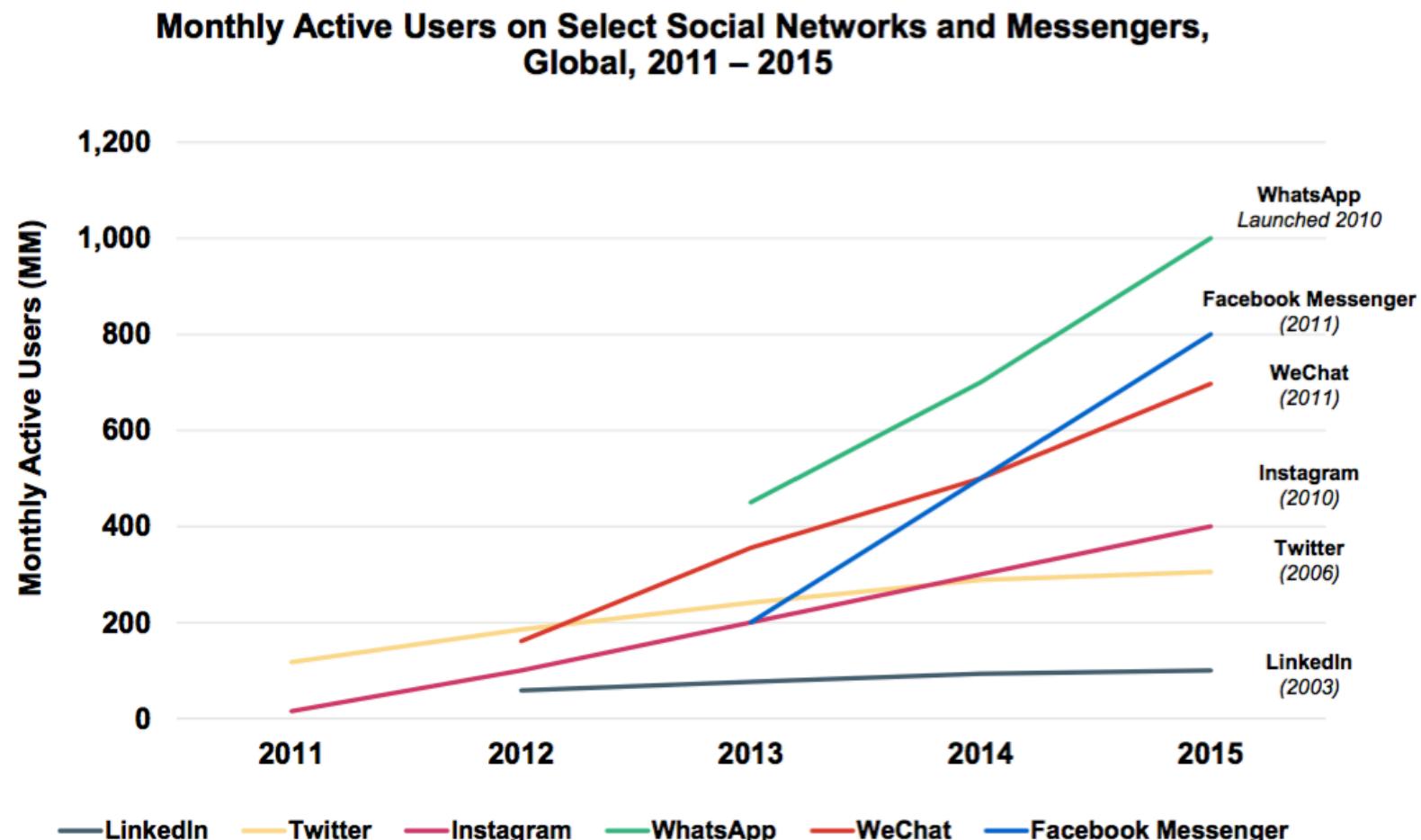
Rank	App	
①		Facebook
②		WhatsApp
③		Messenger
④		Instagram
⑤		LINE
⑥		Viber
⑦		KakaoTalk
⑧		Clash of Clans
⑨		WeChat
⑩		Twitter

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

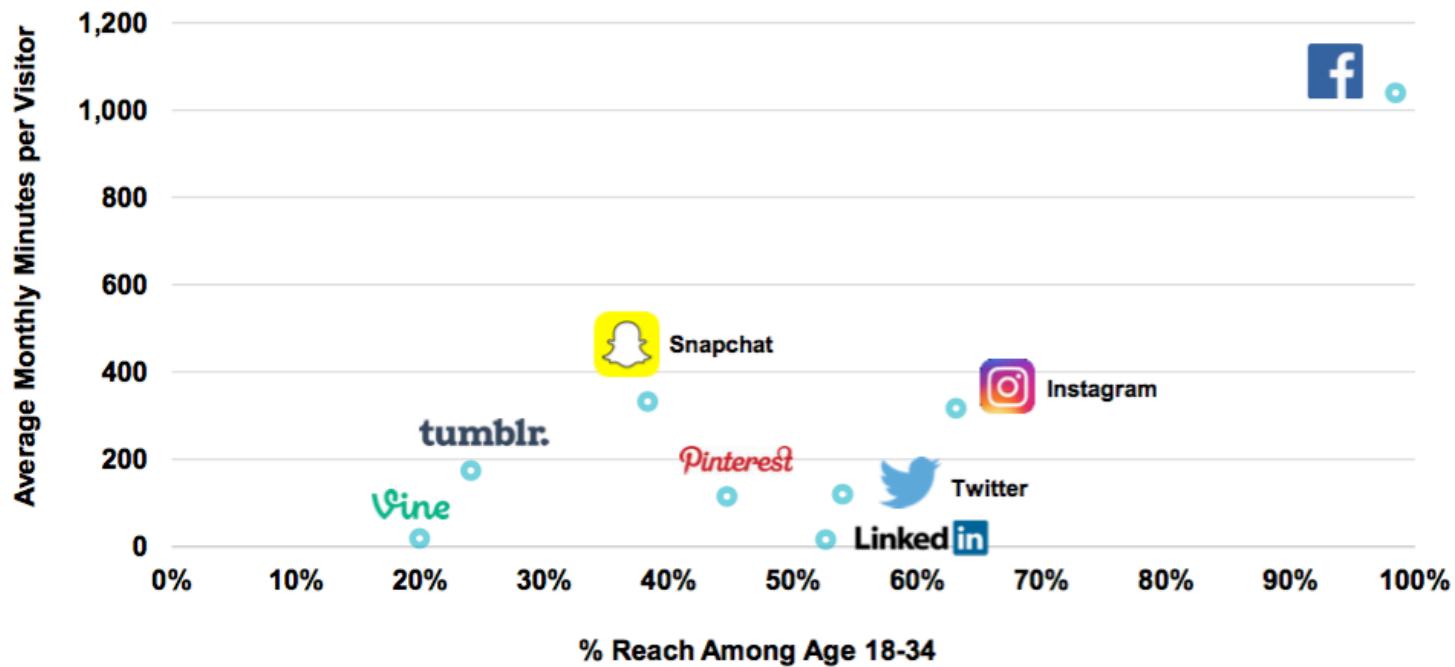
Messaging
Apps →
significant app
sessions

Messaging 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	✗	Enterprise WeChat (3/16)	✗
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)

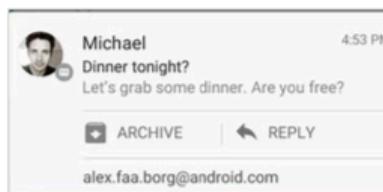
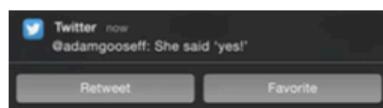
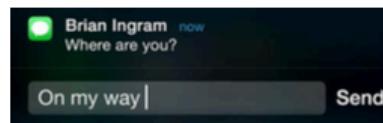
Average Global Mobile User = ~33 Apps...12 Apps Used Daily... 80% of Time Spent in 3 Apps

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

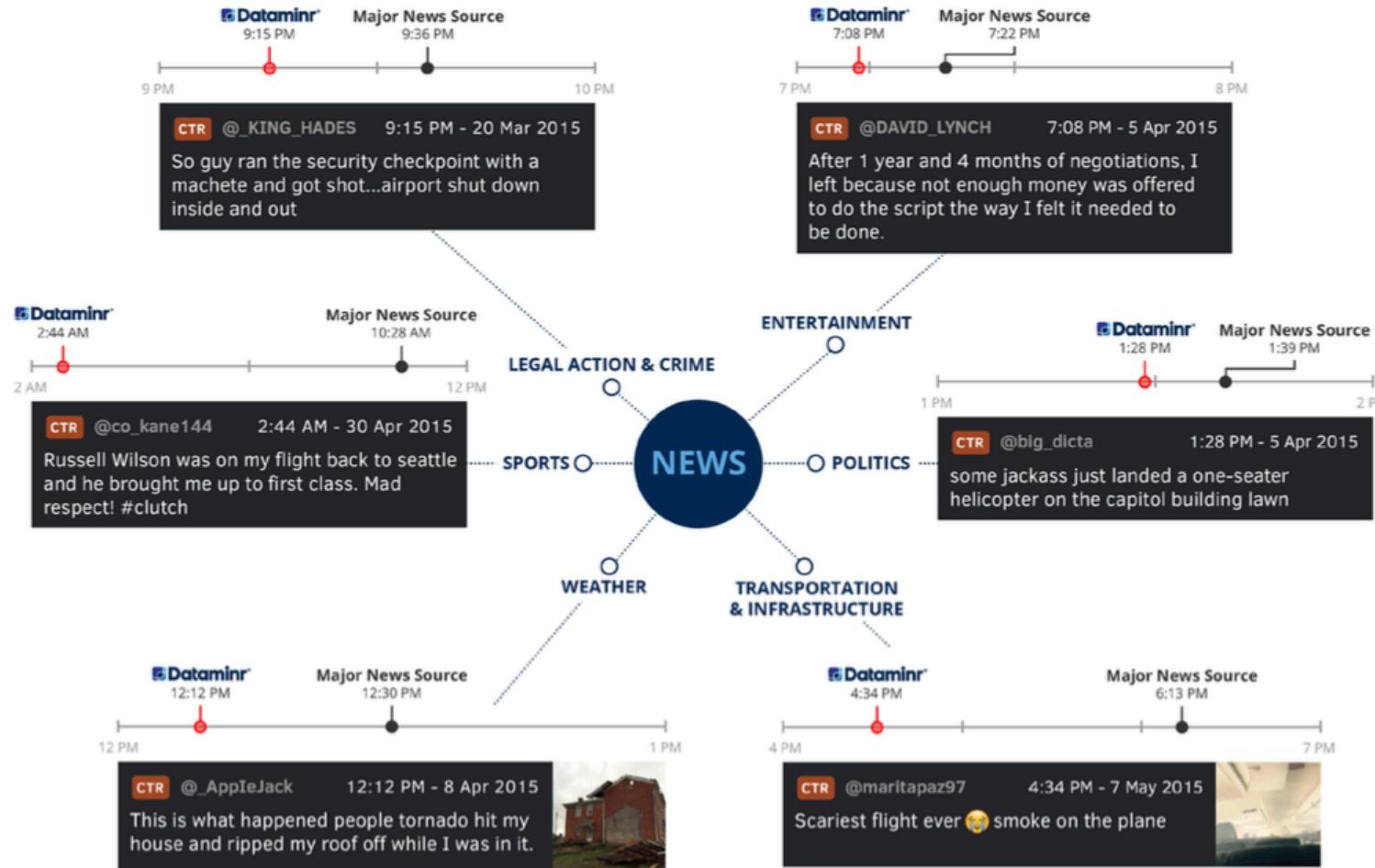
**Direct Interaction
on Notification Panel –**
without users interrupting
what they're doing...



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



Users Increasingly First Source for News via Twitter / Dataminr



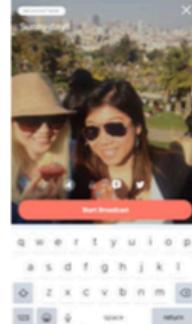
@KPCB

Source: Dataminr, 5/15.

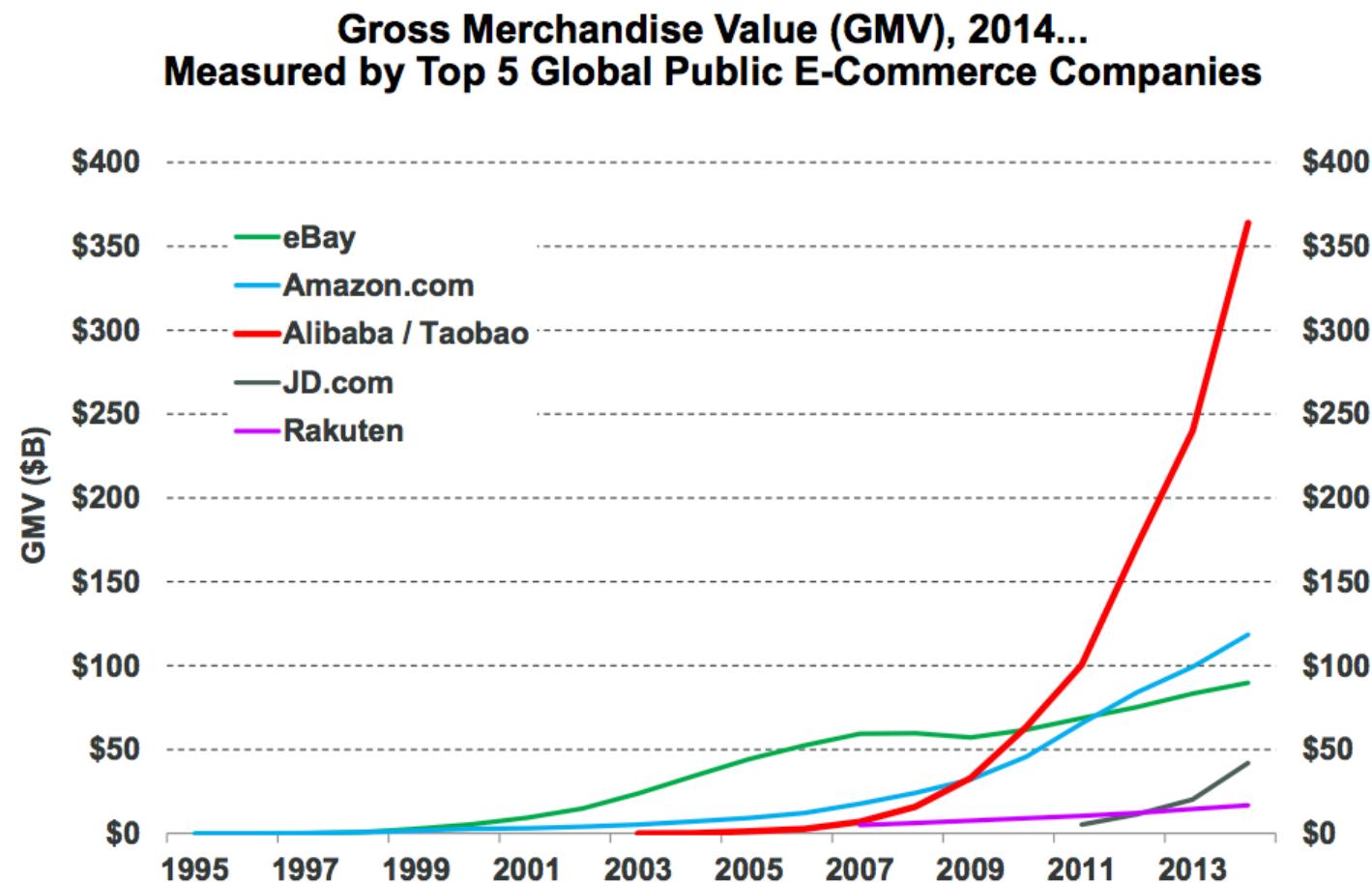
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Video Evolution = Accelerating

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

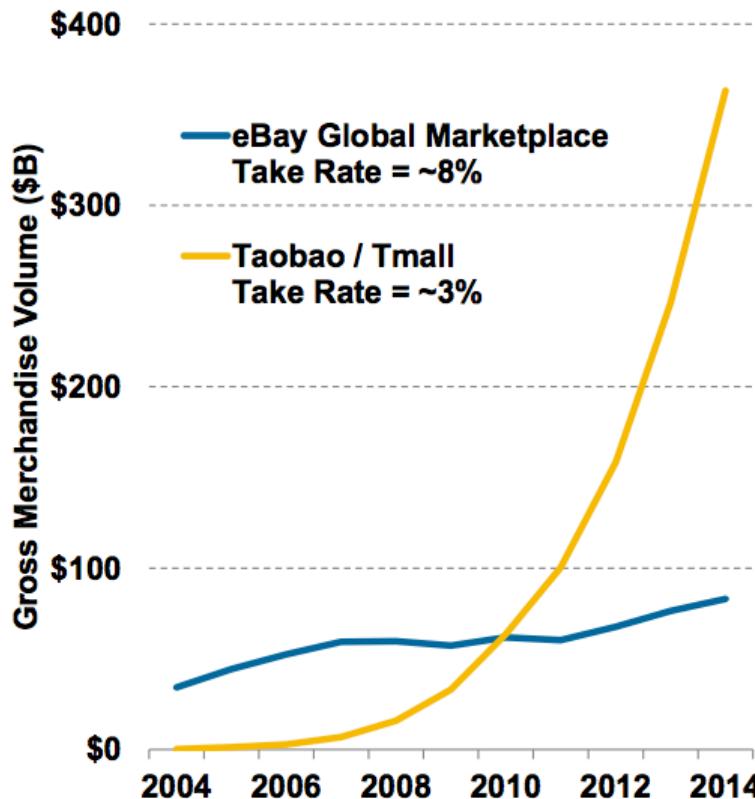
Live (Linear)	On-Demand	Semi-Live	Real-Live
<i>Traditional TV</i> 1926	<i>DVR / Streaming</i> 1999	<i>Snapchat Stories</i> 2013	<i>Periscope + Facebook Live</i> 2015 / 2016
Tune-In or Miss Out	Watch on Own Terms	Tune-In Within 24 Hours or Miss Out	Tune-In / Watch on Own Terms
Mass Concurrent Audience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

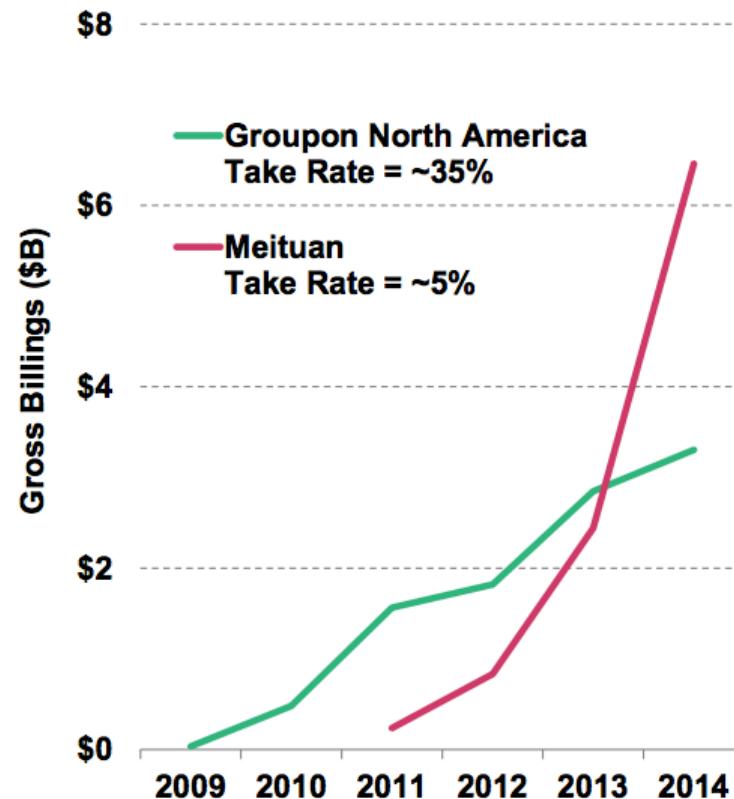


China E-Commerce = Low Take Rates* Helped China Marketplace Leaders Pass USA Peers

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



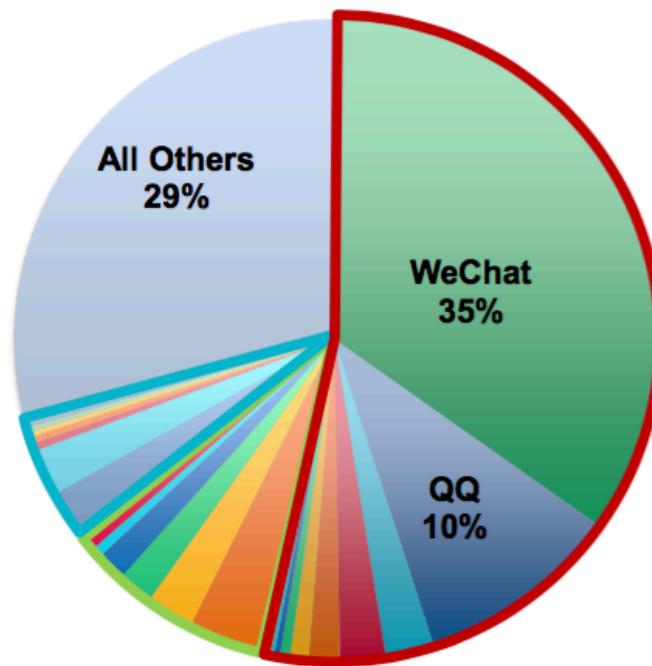
Gross Billings, 2009 – 2014 Groupon N. America vs. Meituan



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

Alibaba

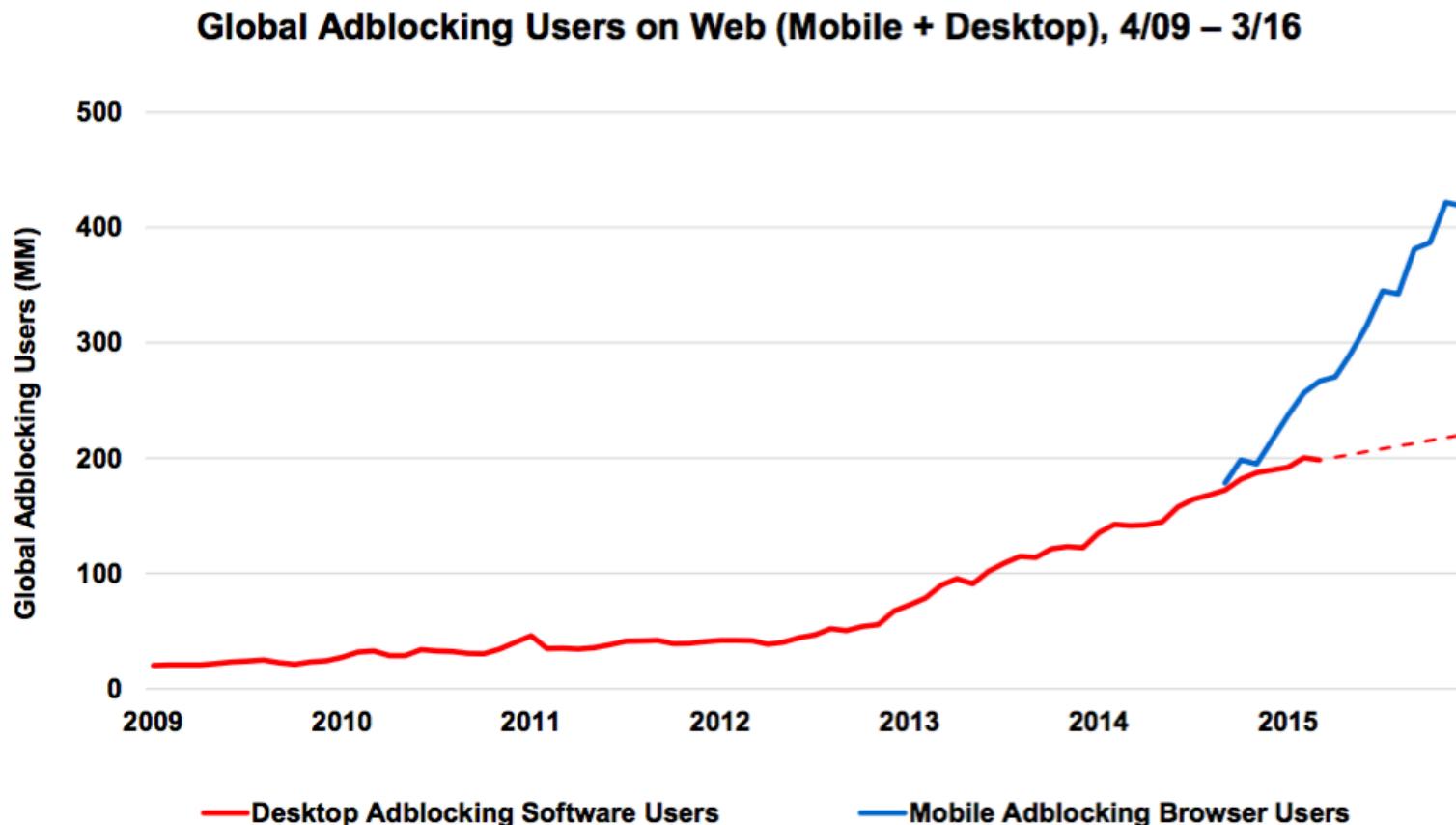
Baidu

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

UCWeb Browser
Taobao
Weibo
YouKu Video
Momo
Shuqi Novel
AliPay
AutoNavi

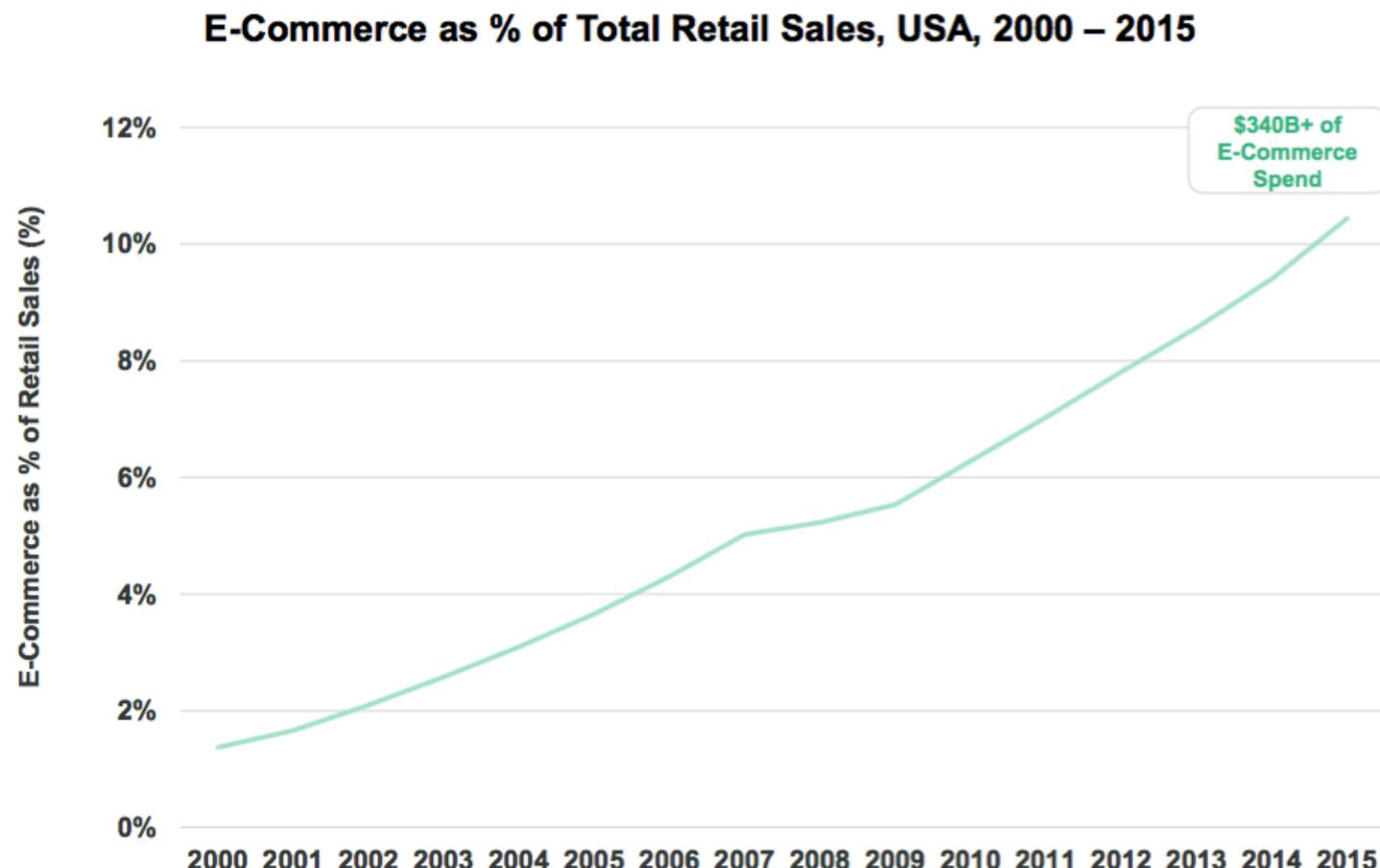
Mobile Baidu
iQiyi / PPS Video
Baidu Browser
Baidu Tieba
91 Desktop
Baidu Maps
All Other

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

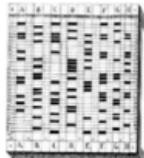


Source: PageFair, 5/16. Dotted line represents estimated data. These two data sets have not been de-duplicated. The number of desktop adblockers after 6/15 are estimates based on the observed trend in desktop adblocking and provided by PageFair. Note that mobile adblocking refers to web / browser-based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

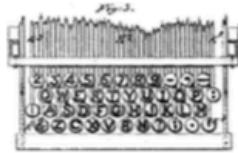
Internet Continues to Ramp as Retail Distribution Channel = 10% of Retail Sales vs. <2% in 2000



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



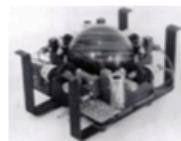
Electronic Computer
(ENIAC)
1943



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

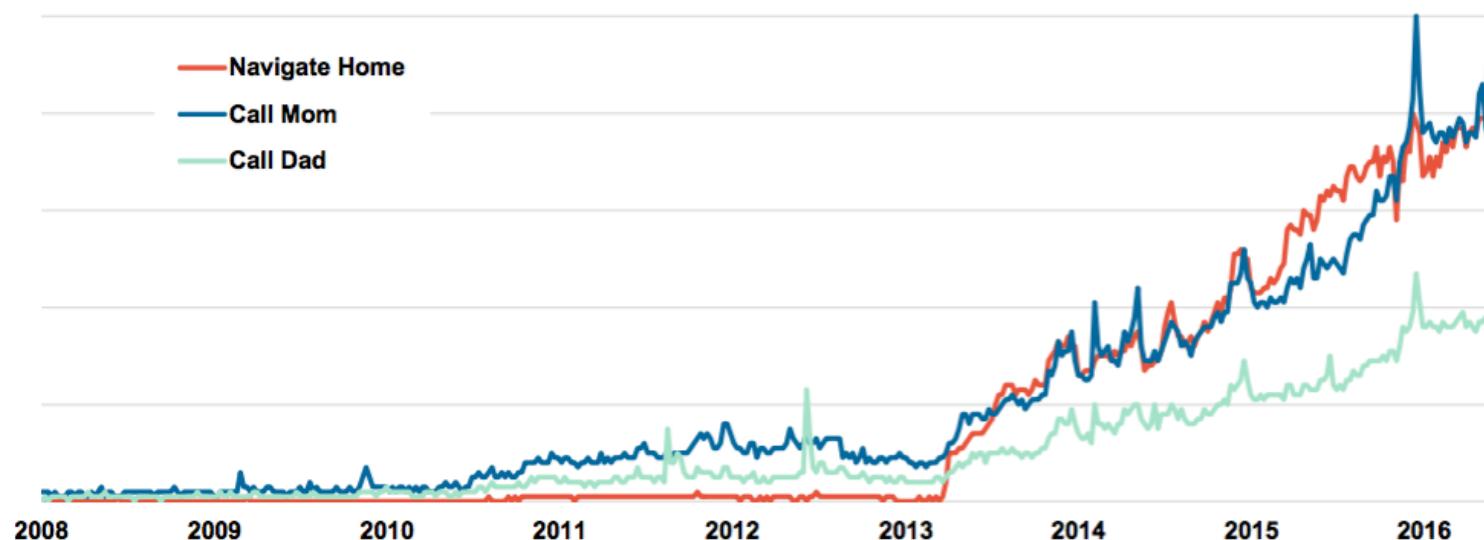


Voice on Connected /
Ambient Devices
(Amazon Echo)
2014

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

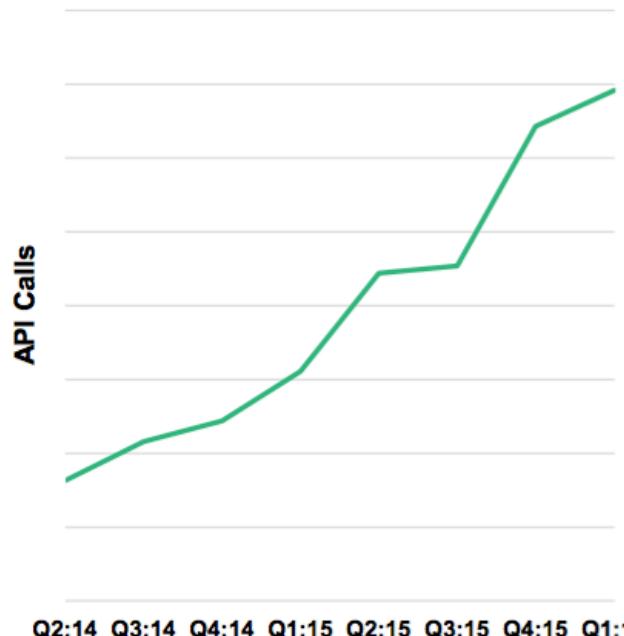
Google Trends, Worldwide, 2008 – 2016



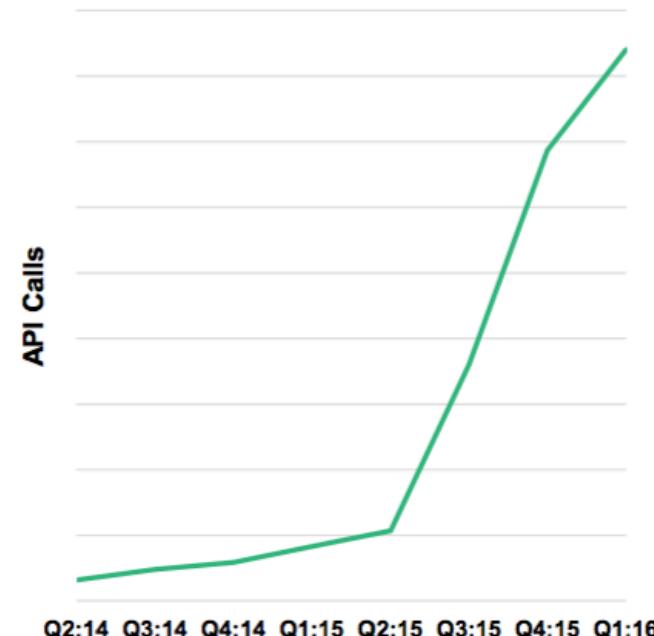
Baidu Voice = Input Growth >4x...Output >26x, Since Q2:14

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**



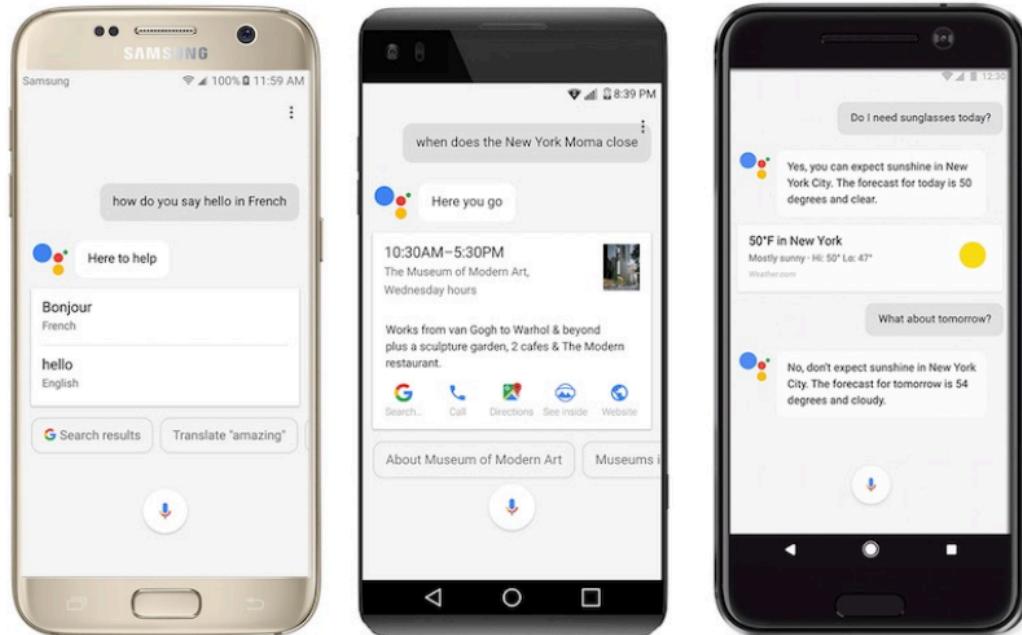
Source: Baidu
Note: (1) Data shown is growth of speech recognition at Baidu, as measured by the number of API calls to Baidu's speech recognition system across time, from multiple products. Most of these API calls were for Mandarin speech recognition. (2) Data shown is growth of TTS (text to speech)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

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



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PERKINS

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

KP INTERNET TRENDS 2017 | PAGE 46

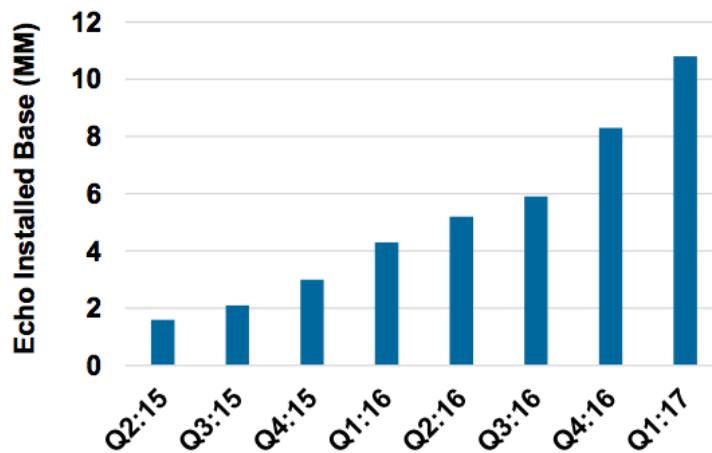
Voice-Based *In-Home* Platform *Front-Ends* = Voice Can Replace Typing

Amazon Echo Evolution, 11/14 – 5/17

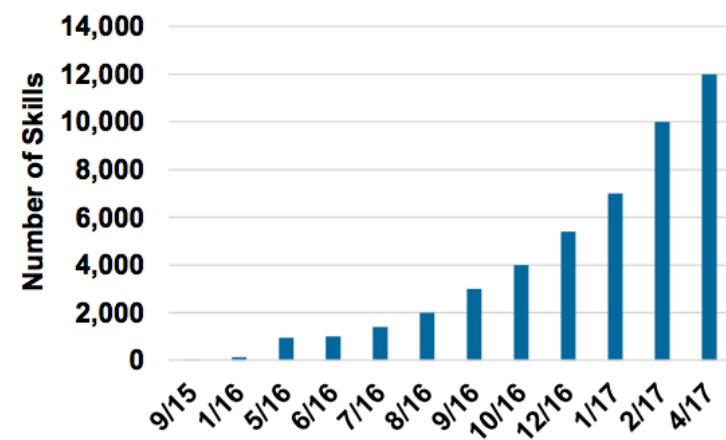


Echo = Shopping + Media
Echo Look = Shopping + Recommendations
Echo Show = Video + Voice Calls

**Amazon Echo Device Installed Base,
USA**



Amazon Echo Skills
Broadening Use Cases



Source: Image: Amazon, Consumer Intelligence Research Partners LLC, Geekwire, Technology Review, Wired, Fast Company

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

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



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



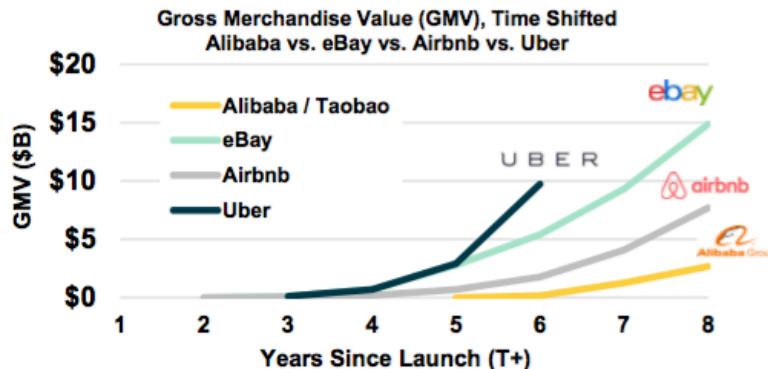
...One Can...

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



Current Generation of Internet Leaders = Growing Faster than Previous Generation

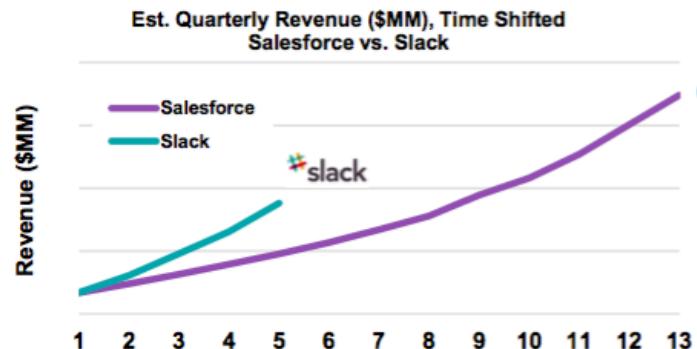
Marketplaces



Commerce



Enterprise



2017 Global Market Capitalization Leaderboard = Tech = 40% of Top 20 Companies 100% of Top 5

Rank	Company	Region	Industry Segment	Current Market Value (\$B)	2016 Revenue (\$B)
1	Apple	USA	Tech – Hardware	801	218
2	Google / Alphabet	USA	Tech – Internet	680	90
3	Microsoft	USA	Tech – Software	540	86
4	Amazon	USA	Tech – Internet	476	136
5	Facebook	USA	Tech – Internet	441	28
6	Berkshire Hathaway	USA	Financial Services	409	215
7	Exxon Mobil	USA	Energy	346	198
8	Johnson & Johnson	USA	Healthcare	342	72
9	Tencent	China	Tech – Internet	335	22
10	Alibaba	China	Tech – Internet	314	21
11	JP Morgan Chase	USA	Financial Services	303	90
12	ICBC	China	Financial Services	264	85
13	Nestlé	Switzerland	Food / Beverages	263	88
14	Wells Fargo	USA	Financial Services	262	85
15	Samsung Electronics	Korea	Tech – Hardware	259	168
16	General Electric	USA	Industrial	238	120
17	Wal-Mart	USA	Retail	237	486
18	AT&T	USA	Telecom	234	164
19	Roche	Switzerland	Healthcare	233	51
20	Bank of America	USA	Financial Services	231	80
Total				\$7,207	\$2,497

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PERKINS

Source: CapIQ. Market value data as of 5/26/17

Note: For public companies, colors denote current market value relative to Y/Y market value. Green = higher, red = lower.

KP INTERNET TRENDS 2017 | PAGE 324

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]

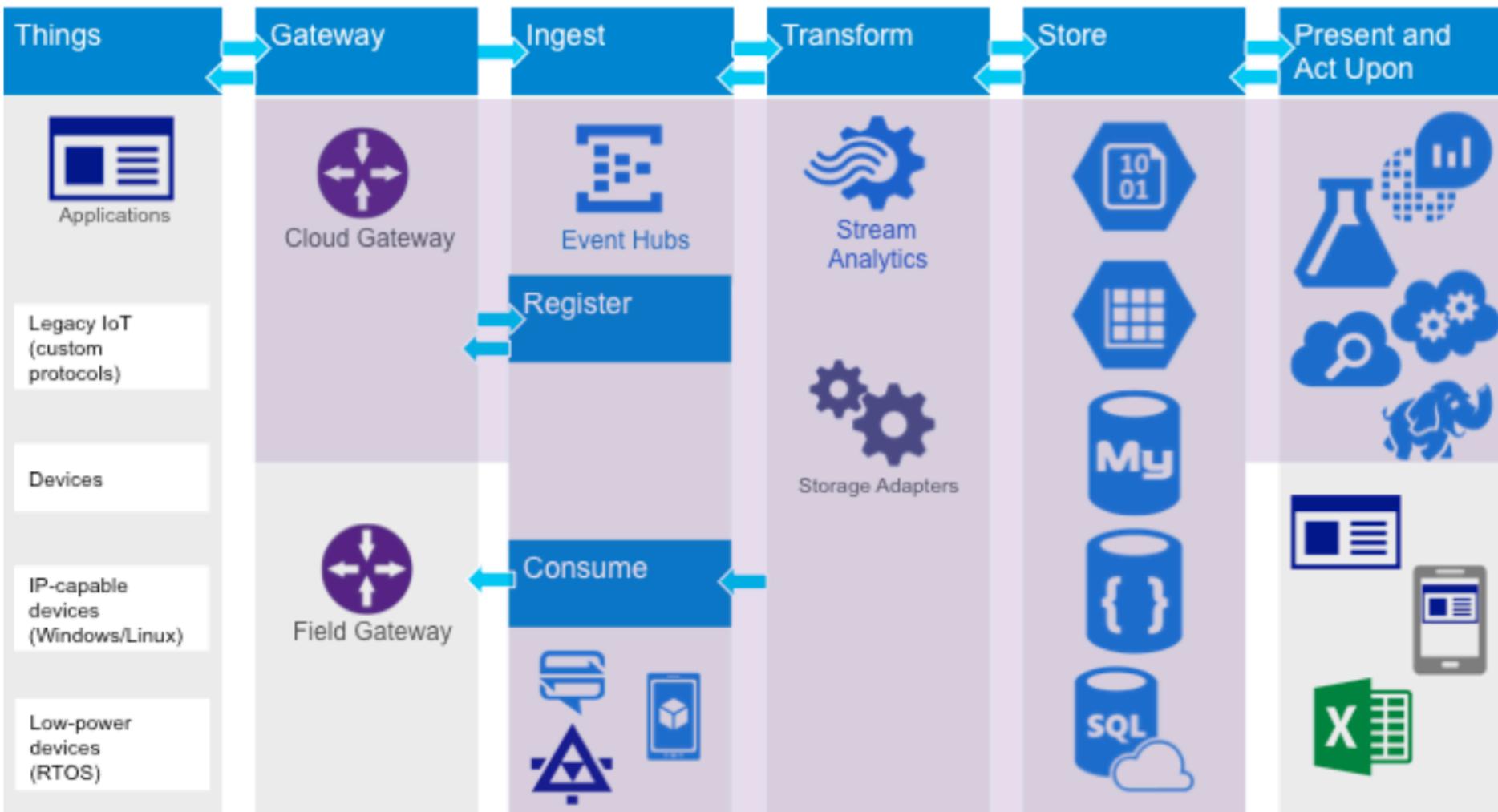
Types of IoT



Consumer



(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:

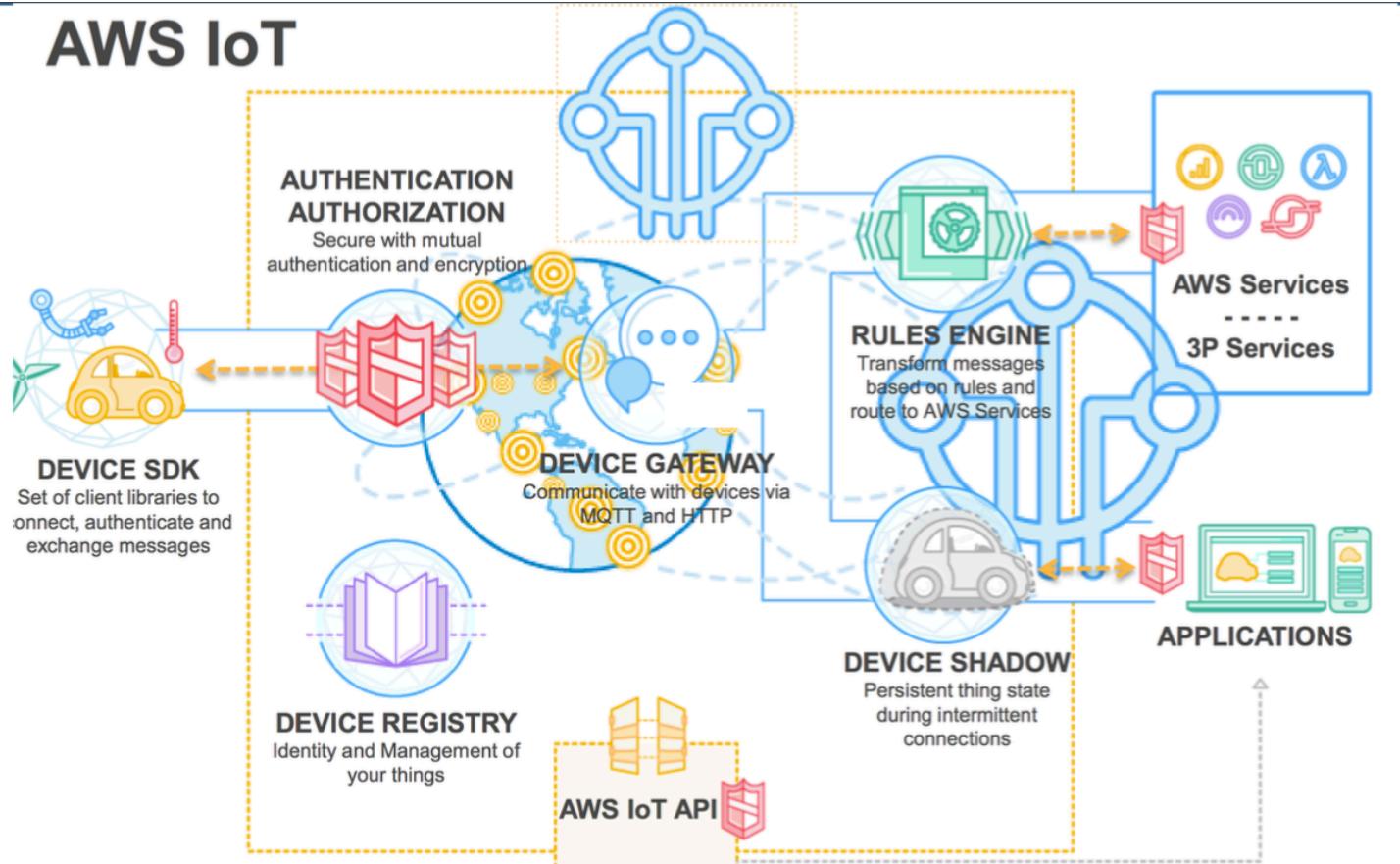
- ModBus TCP – Common
- OPC - Common for industrial assets
- HTTP – JSON over HTTP
- MQTT - Consumer oriented, promising

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



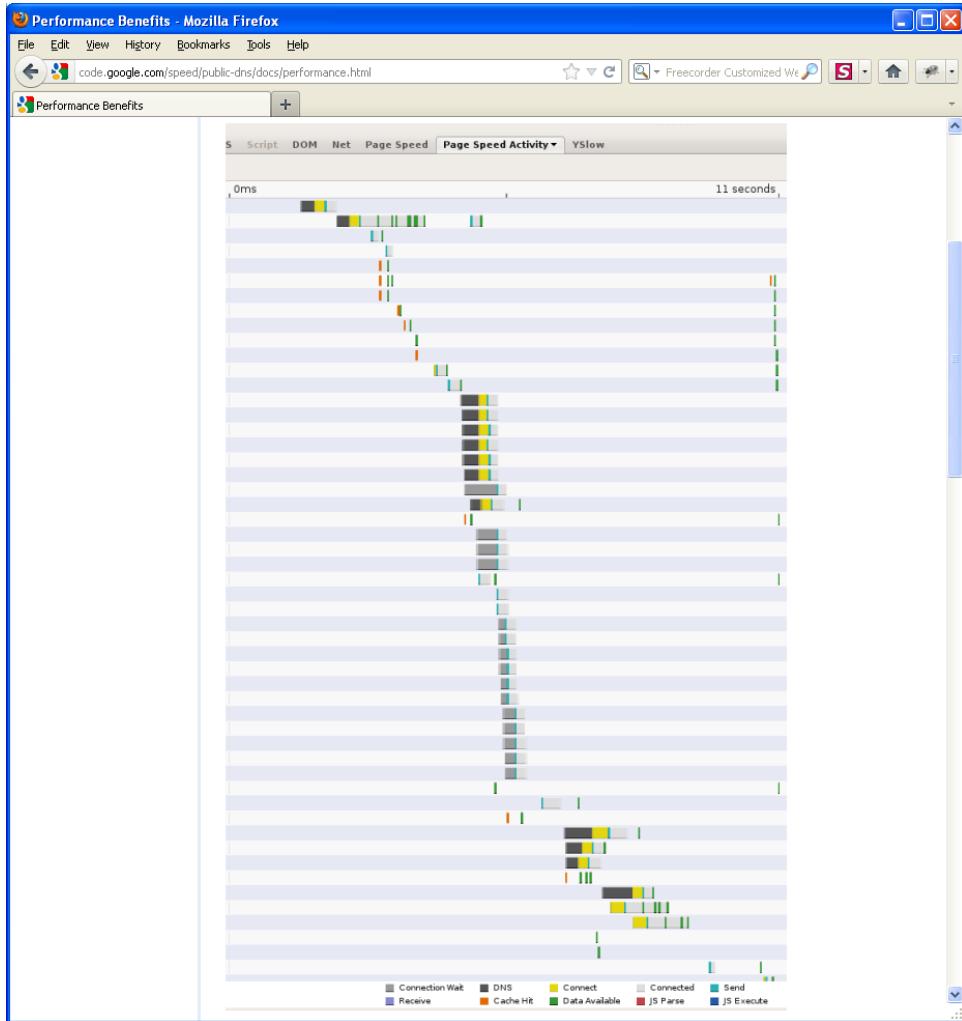
Domain Name System

- 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.org



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 2016,
at <http://ftp.isc.org/www/survey/reports/2016/01/bynum.txt>

Domain	Hosts =	All	- Dup	Level 2	Level 3	
TOTAL	1048766623	1141884150	93117527	5105977	135897307	
net	396906692	407613994	10707302	384866	69562330	Networks
com	141922826	192354009	50431183	2933724	26113151	Commercial
jp	76093898	76275971	182073	66239	895409	Japan
de	47221403	47413763	192360	184175	2721146	Germany
br	45591541	46294459	702918	1616	305271	Brazil
it	28646378	28749103	60902	40750	814460	Italy
cn	20226105	20354373	12068	35932	675789	China
fr	18918902	20510466	1591564	2101	121390	Mexico
au	15737052	15926132	189073	72	87830	Australia
ar	15032762	15271462	238700	41	14356	Argentina
nl	14357662	14610694	253025	70089	3445944	Netherlands
ru	13080542	13848964	768422	103414	3602589	Russian Federation
pl	13050905	13139984	89079	24048	2262488	Poland
edu	12572729	12572729	375213	9599	377748	Educational
ca	9614359	9849979	35710	39616	1208147	Canada
in	7123768	7197648	73800	11042	90994	India
tr	70494478	7079548	30100	28	8911	Turkey
tw	6792887	6854252	61365	1500	27810	Taiwan
co	5938607	6250774	312167	8162	37220	Colombia
uk	5901976	7015340	1113364	983	125002	United Kingdom
za	5804377	5924837	120460	57	24399	South Africa
se	5712373	5800242	87869	16548	454080	Sweden
be	551885	551885	24797	22130	15740	Belgium
ch	5240963	535237	112494	30499	1354274	Switzerland
eg	5037286	5038589	1303	31	897	Egypt
fi	4814297	4840912	26615	14742	1980519	Finland
es	4656899	4695121	38222	13801	532620	Spain
pt	40530485	4321730	16245	7802	298009	Portugal
no	4066322	4099920	33595	14726	303238	Norway
th	3825455	3838878	12915	16	4602	Thailand
at	3782144	381244	35815	27687	360038	Austria
arpa	3667959	471011	11011	111	6100	Microsoft
cz	3651708	3670352	35644	30966	1054510	Czech Republic
hu	3393975	3407905	13930	17465	671404	Hungary
cl	3305481	3395778	90290	11251	65177	Chile
gr	3176592	3184563	7971	8988	94221	Greece
nz	3168619	3224993	56374	217	22808	New Zealand
mil	2867725	5377840	2570115	193	241681	US Military
ro	2667475	2834009	166534	25547	1946770	Romania
ua	244268	261158	18000	2304	10000	Ukraine
dk	2444678	2479513	34825	16917	124610	Denmark
gov	2322988	303996	981008	2831	659716	Government
il	2313675	2359195	45520	23	11795	Israel
org	2260510	2466541	206031	269595	1504609	Organizations
us	2088061	2216624	128563	23442	91575	United States
id	1945601	1988609	43001	218	9172	Indonesia
uy	1798339	1802365	4026	68	1856	Uruguay
hr	1629456	173736	2210	1815	7075	Croatia (local name: Hrvatska)
ie	1547463	158600	975	9160	24879	Ireland
ve	1534047	1546672	12625	31	3001	Venezuela
lt	1514018	1518685	4667	5171	418963	Lithuania
unknown	1444830	14393792	12948962	323423	532028	Unknown
sg	1444211	2128512	684301	1135	9487	Singapore
ir	140104	1407028	5982	1355	1314243	Iran (Islamic Republic Of)
sk	1350764	1355757	4993	6820	275968	Slovakia (Slovak Republic)
kz	1187434	1217223	29789	3489	550082	Kazakhstan
ra	1125702	1129381	3679	1809	43519	

Top-level Domains (TLDs) Overview

For the day of December 19, 2016

TLD	New	Deleted	Transferred	Current Total
.COM	70,850	229,340	108,154	127,615,274
.NET	7,059	18,991	12,120	15,448,297
.ORG	4,888	9,161	6,358	10,596,114
.INFO	2,503	5,543	4,441	5,468,611
.BIZ	710	6,180	20,463	2,352,705
.US	1,757	1,003	853	2,288,362
TOTALS	87,767	270,218	152,389	163,769,363

Above shows 127 million .com sites out
Of a total 163 million; see
<http://www.dailychanges.com>

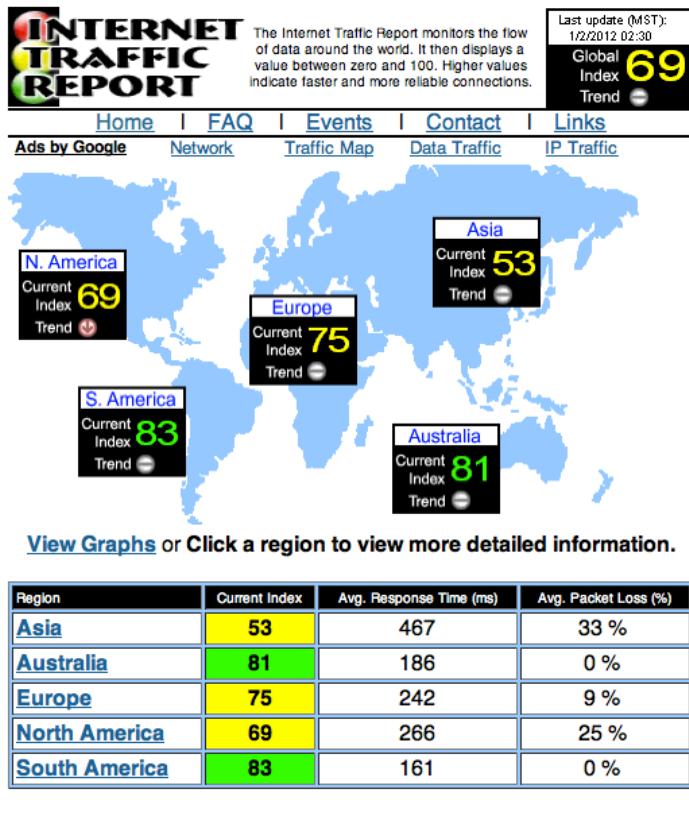
Try also:

<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/>
 - <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

NetFlow report for the week of 20100426

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% 95.81T	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% 9.465T	0.43% 10.29G
Games	0.23% 4.241T	0.38% 9.141G
Unidentified	46.83% 855.17T	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):

Table 7. Detailed Application Types (Full Data Set)

Traffic type	Octets	Packets
Data Transfers	---	---
HTTP	37.24% 679.9T	39.92% 966.9G
Rsync	0.93% 17.05T	0.71% 17.26G
FTP	0.73% 13.30T	0.53% 12.78G
NNTP	0.18% 3.304T	0.24% 5.802G
Encrypted Traffic	---	---
HTTPS	2.63% 48.02T	3.61% 87.32G
SSH	2.33% 42.55T	1.98% 47.95G
IPsec ESP	0.28% 5.131T	0.34% 8.255G
IPsec AH	0.00% 83.91G	0.01% 181.4M
IPsec IKE	0.00% 16.98G	0.00% 61.63M

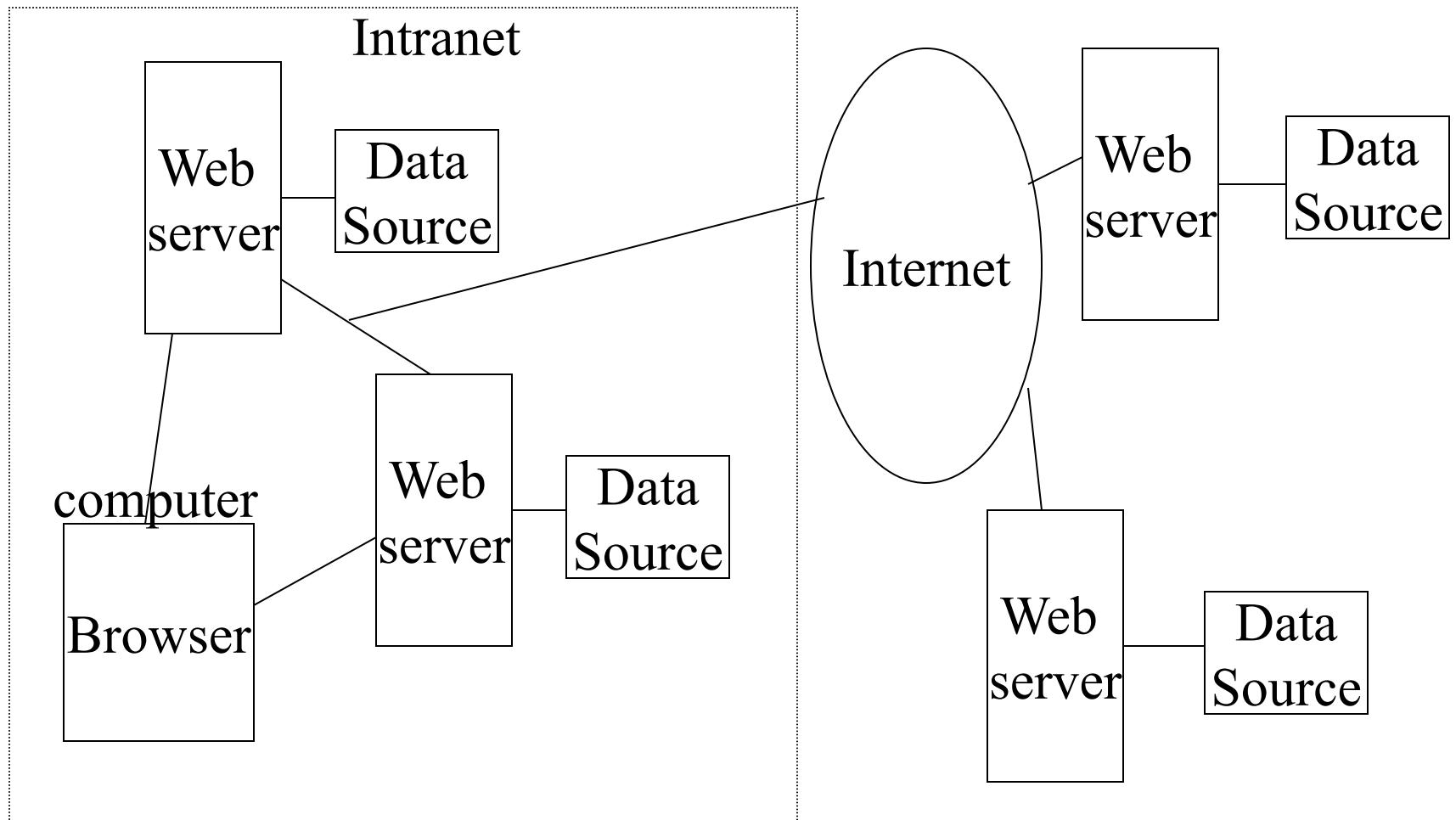
In April 2010:
Data Transfers was 41%

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

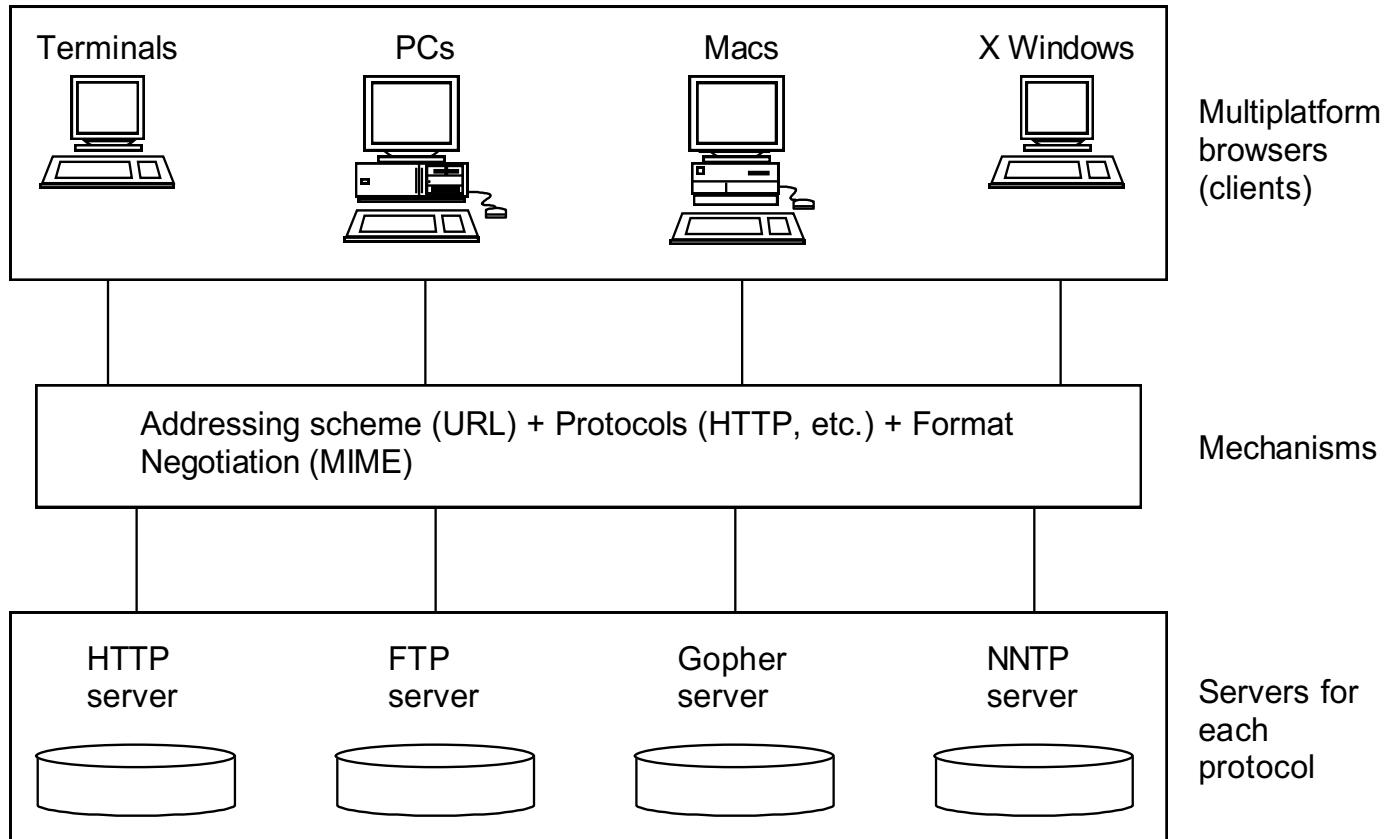
Graphical View of the WWW



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

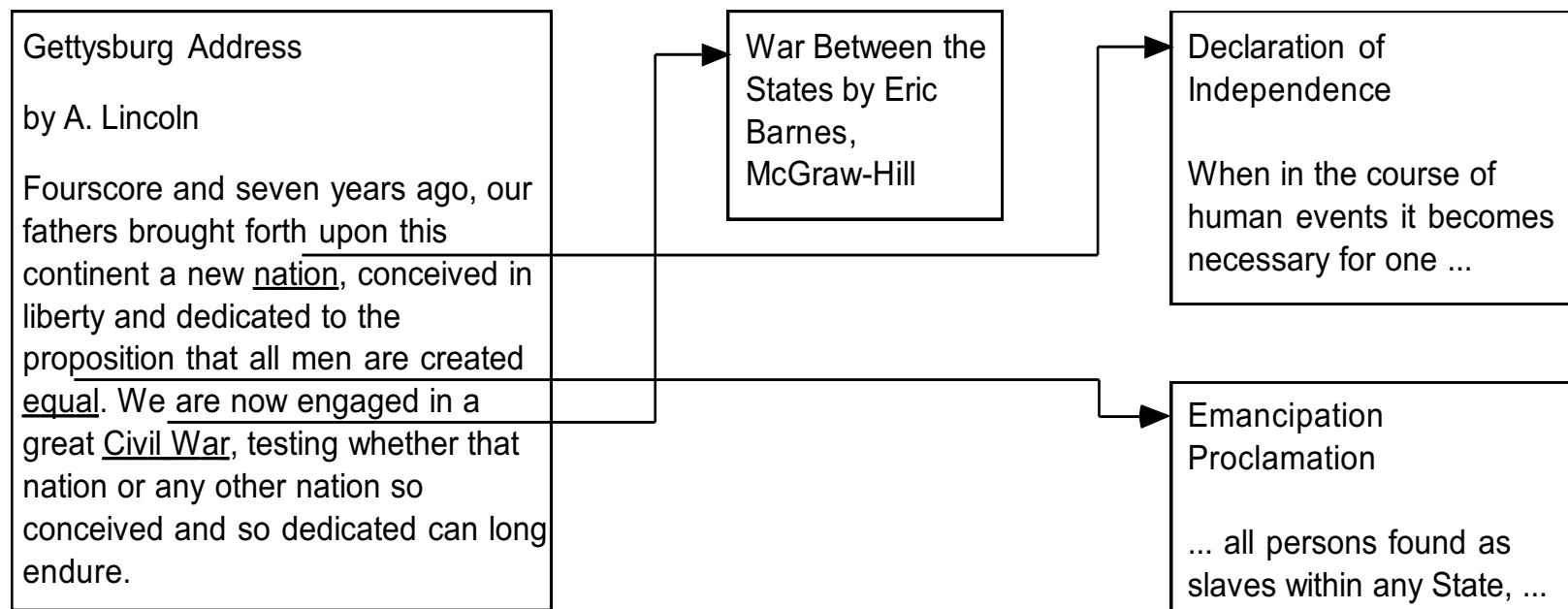
~	%7E		%7C
SPACE	%20	\	%5C
%	%25	^	%5E
&	%26	[%5B
=	%3D]	%5D
?	%3F	#	%23
{	%7B	>	%3E
}	%7D	<	%3C

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

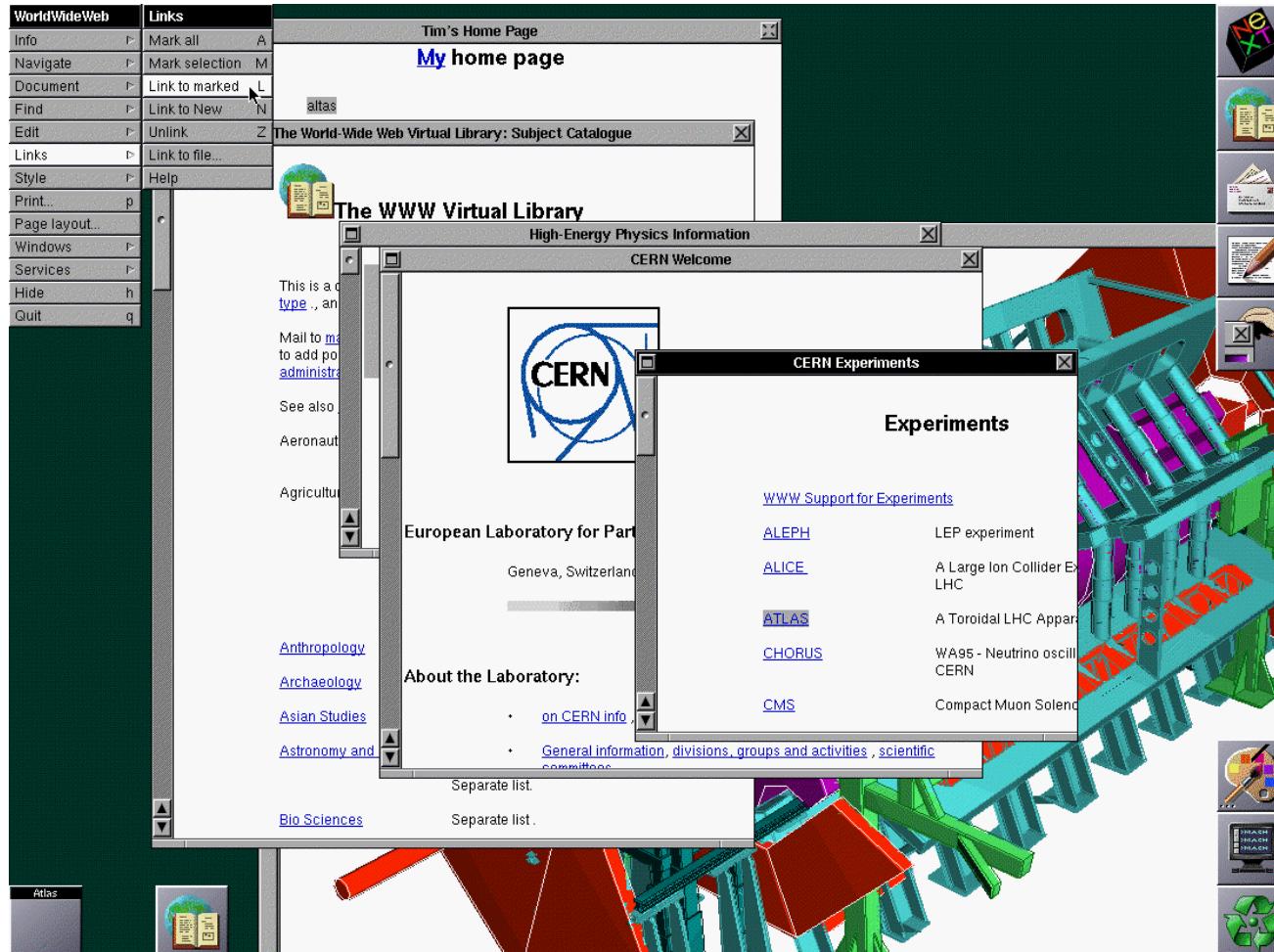


Early History of the WWW

- 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
- 1995 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>



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.