

Lecture

Internet Trends and Web Basics

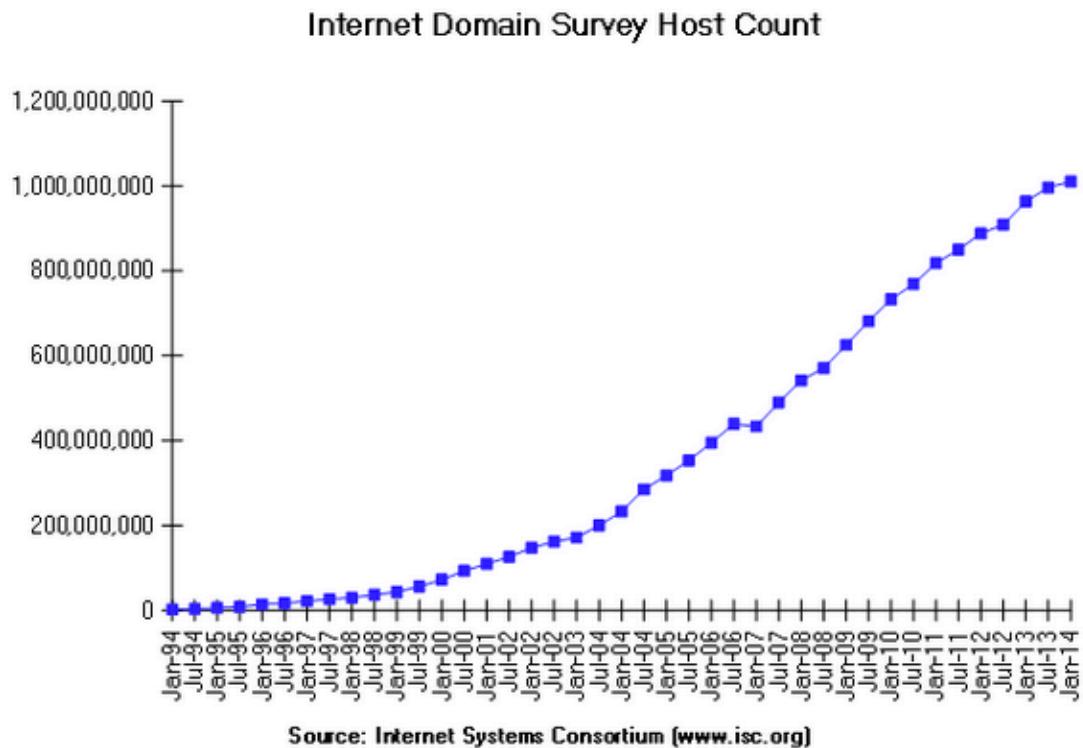
The Internet and the WWW are Different

- 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/solutions/survey>



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

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Date	HostCount
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

Established ‘Big’ Internet Markets (China / USA / Japan / Brazil / Russia) = +7% Growth in 2013 vs. 8% Y/Y = Slowing, Past / Near 50% Penetration

As of 2013 there are 2.6 billion Internet users, with yearly growth at 6%; China and the USA have the largest number of Internet users and the penetration of the population in China remains small

Countries with Internet Penetration >45%, 2013

Rank	Country	2013 Internet Users (MMs)	2013 Internet User Growth	2012 Internet User Growth	Population Penetration	Total Population (MMs)
1	China	618	10%	10%	46%	1,350
2	USA	263	2	2	83	316
3	Japan	101	0	1	79	127
4	Brazil	100	12	12	50	201
5	Russia	76	9	14	53	143
6	Germany	68	1	1	84	81
7	United Kingdom	55	1	3	87	63
8	France	55	5	4	83	66
9	Iran	45	16	19	56	80
10	South Korea	41	1	0	84	49
11	Turkey	36	6	9	45	81
12	Italy	36	2	6	58	61
13	Spain	34	7	3	72	47
14	Canada	30	5	4	87	35
15	Poland	25	0	4	65	38
Top 15		1,583	6%	7%	58%	2,739
World		2,609	9%	11%	37%	7,098



Source: United Nations / International Telecommunications Union, US Census Bureau.
 China Internet user data from CNNIC (12/2013). Iran Internet user data from KPCB estimates per data from Islamic Republic News Agency, citing data released 155 by the National Internet Development Center.

The following 16 slides are based upon a presentation by Mary Meeker and Liang Wu of Kleiner Perkins Caufield and Byers, see <http://www.kpcb.com/insights/2014-internet-trends>

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

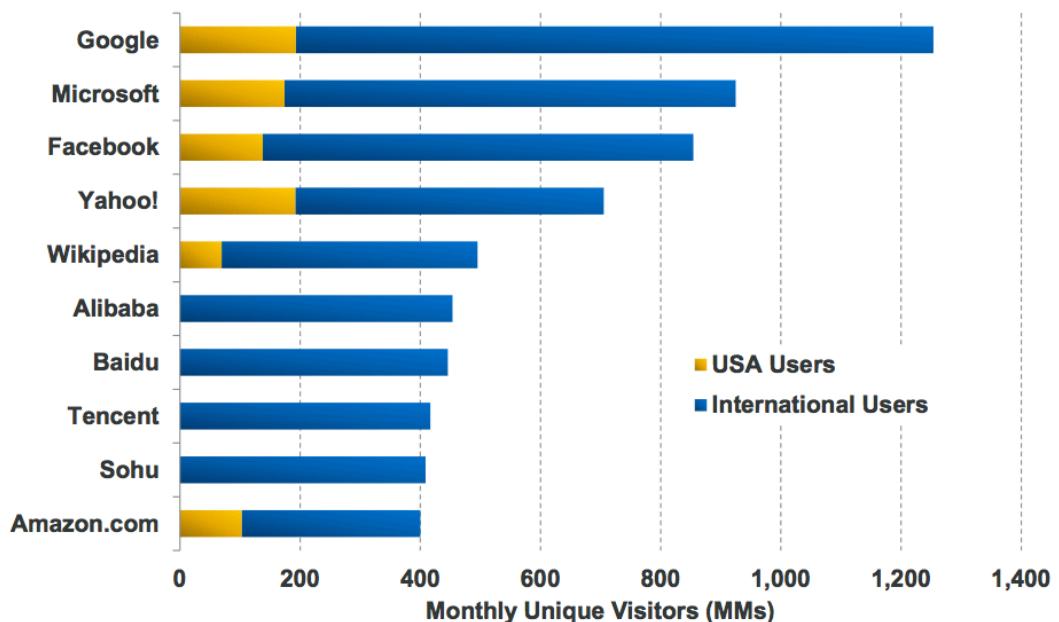
Baidu is a Chinese search engine

Tencent is a Chinese holding company of Internet properties, among the most popular being, QQ, for chatting;

Sohu.com Inc. is a Chinese online media, search, gaming, community and mobile service group.

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

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

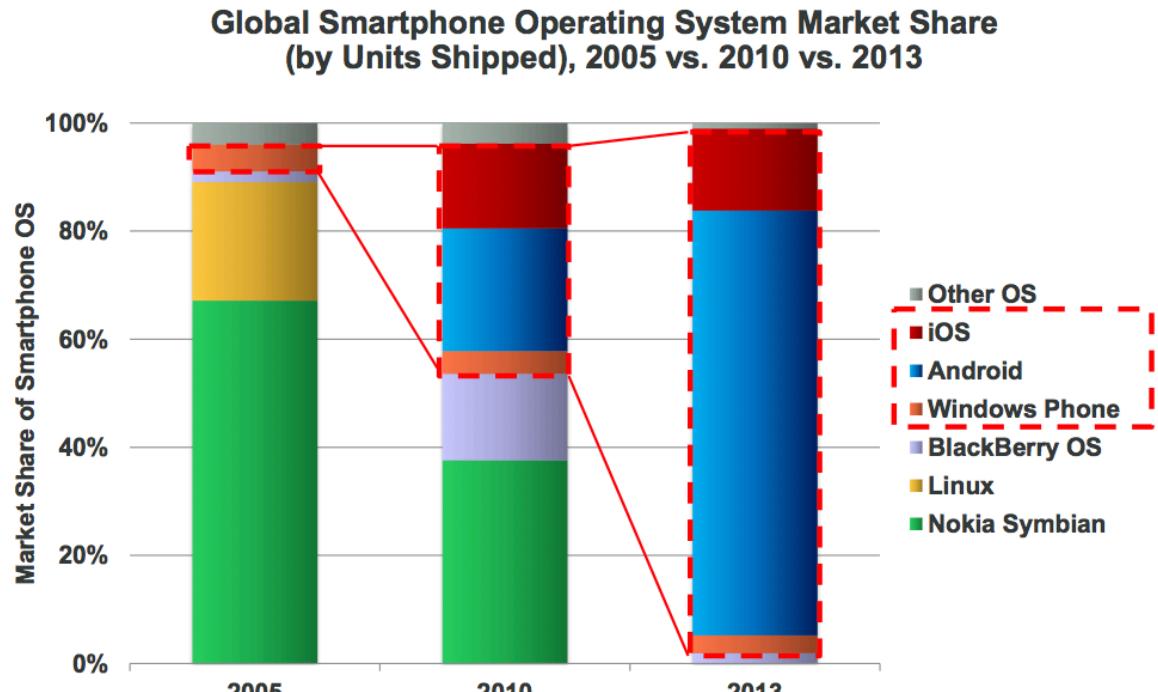


@KPCB Source: comScore, 3/14.

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

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



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

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

There has been exponential growth in online information;

1 Zettabyte = 1,024 Exabytes

1 Exabyte = 1,024 Petabytes

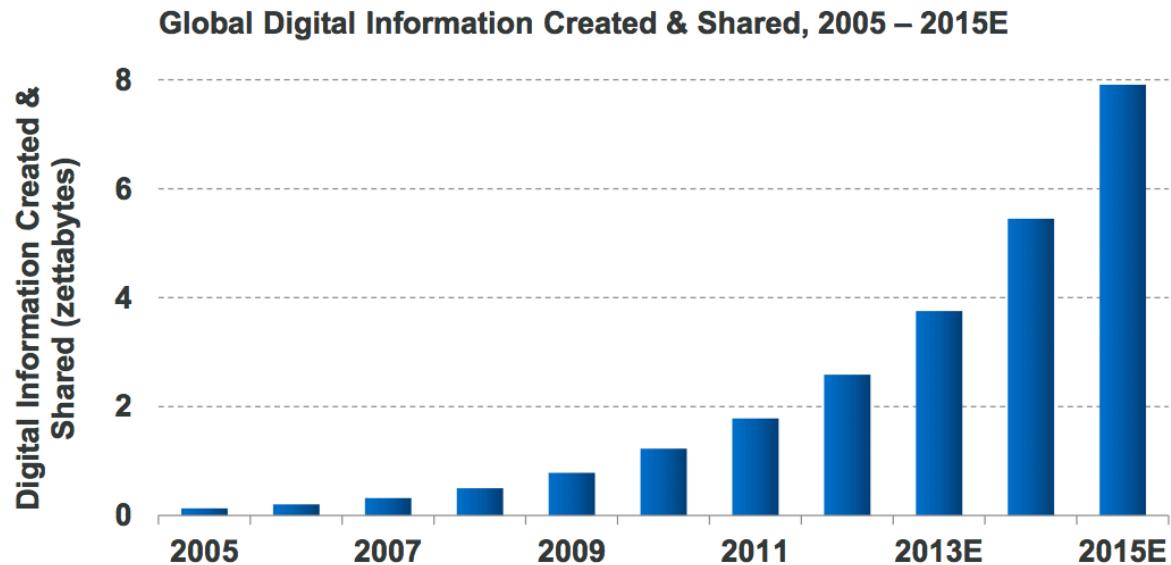
1 Petabyte = 1,024 Terabytes

1 Terabyte = 1,024 Gigabytes

or

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

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



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

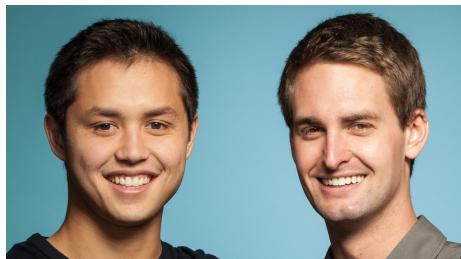
Photos Alone = 1.8B+ Uploaded & Shared Per Day... Growth Remains Robust as New Real-Time Platforms Emerge

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

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

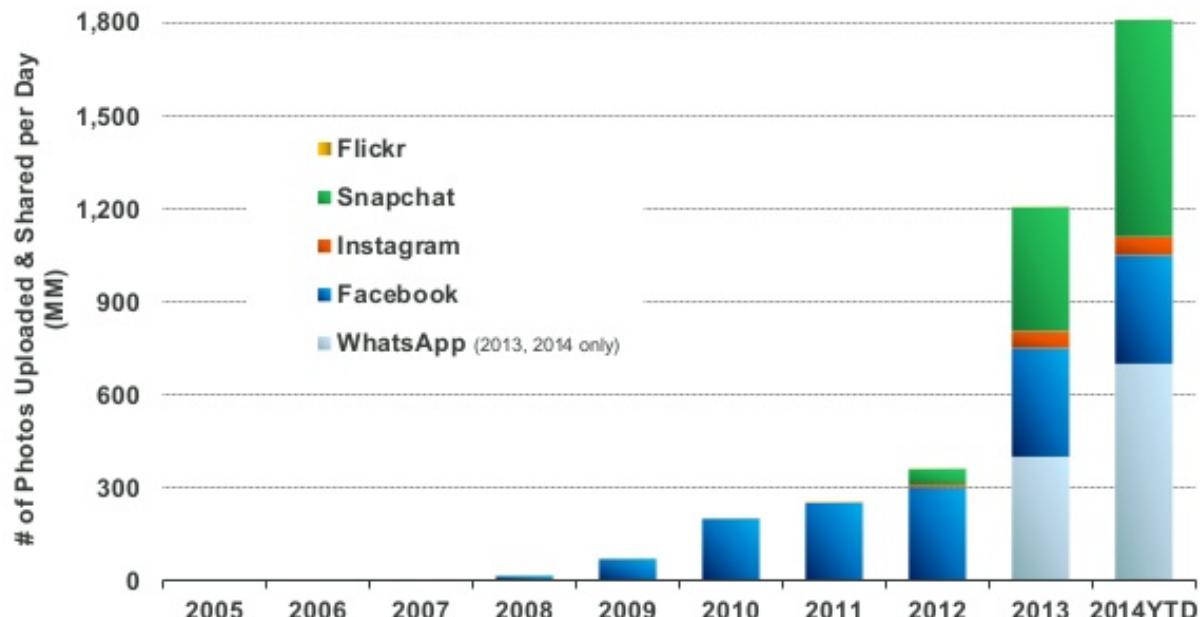
Instagram was recently (2010) purchased by Facebook for \$1 billion

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



bobby Murphy - Evan Spiegel

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

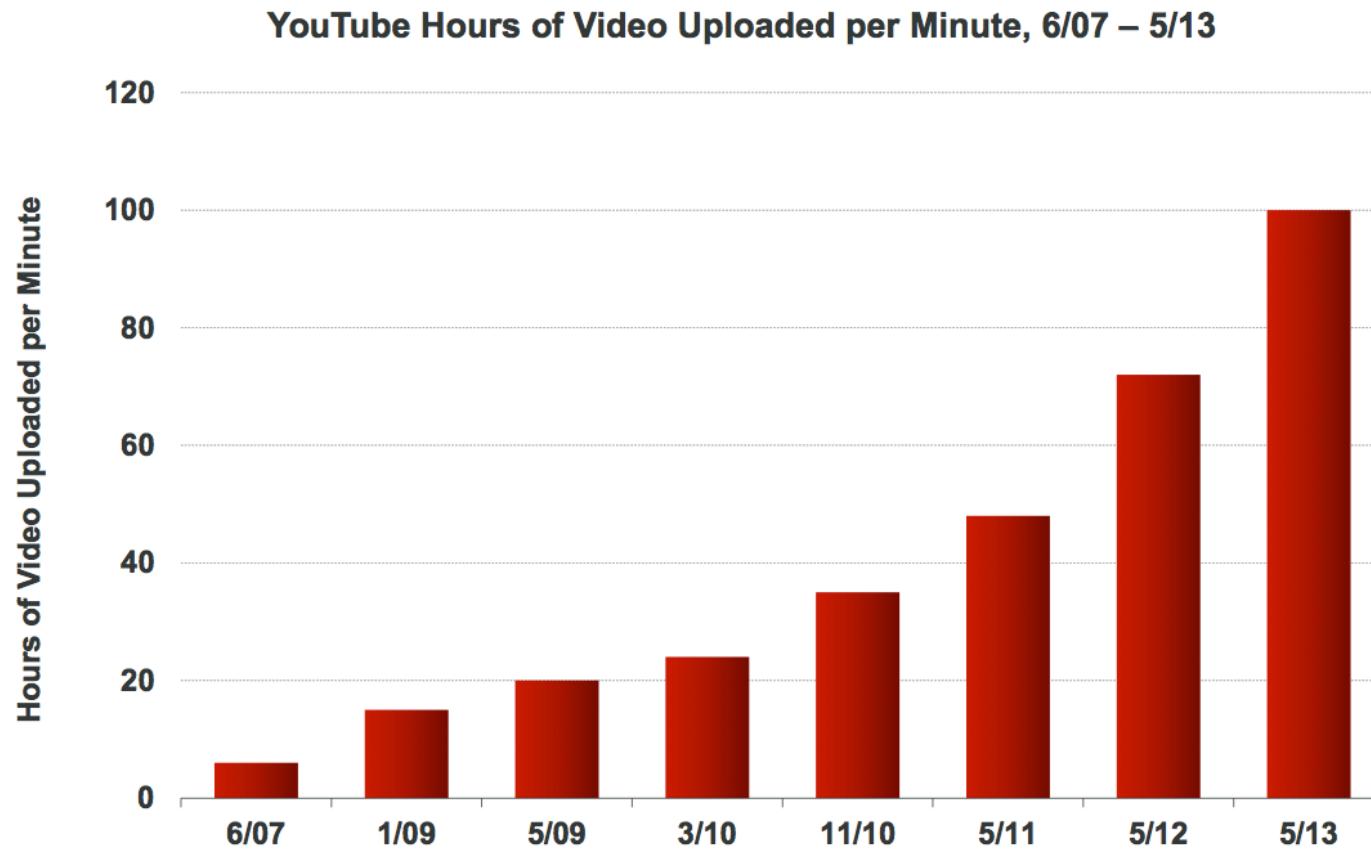


Source: KPCB estimates based on publicly disclosed company data. 2014 YTD data per latest as of 5/14.

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



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Source: YouTube.

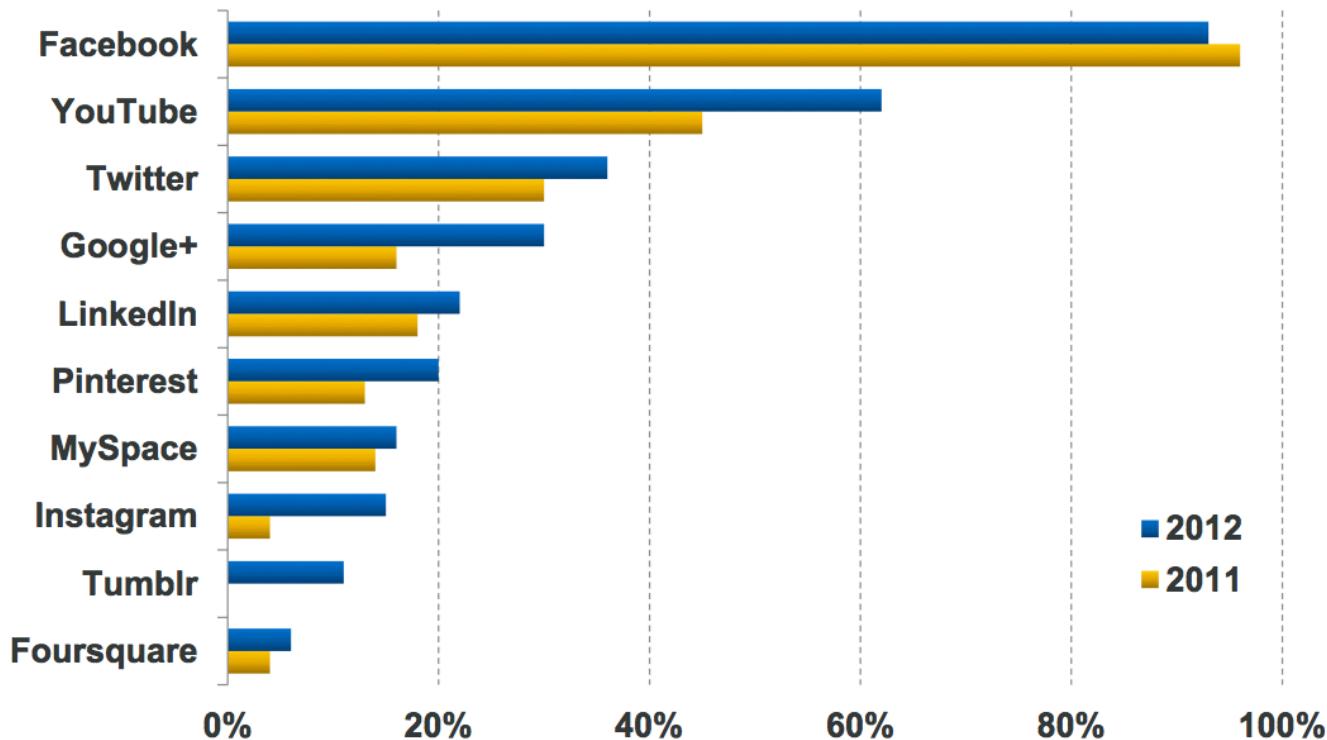
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Social Media – Facebook Leads, YouTube + Twitter + Google+ + Pinterest + Instagram + Tumblr Rising Fast

Which of the Following Social Media Do You Use?

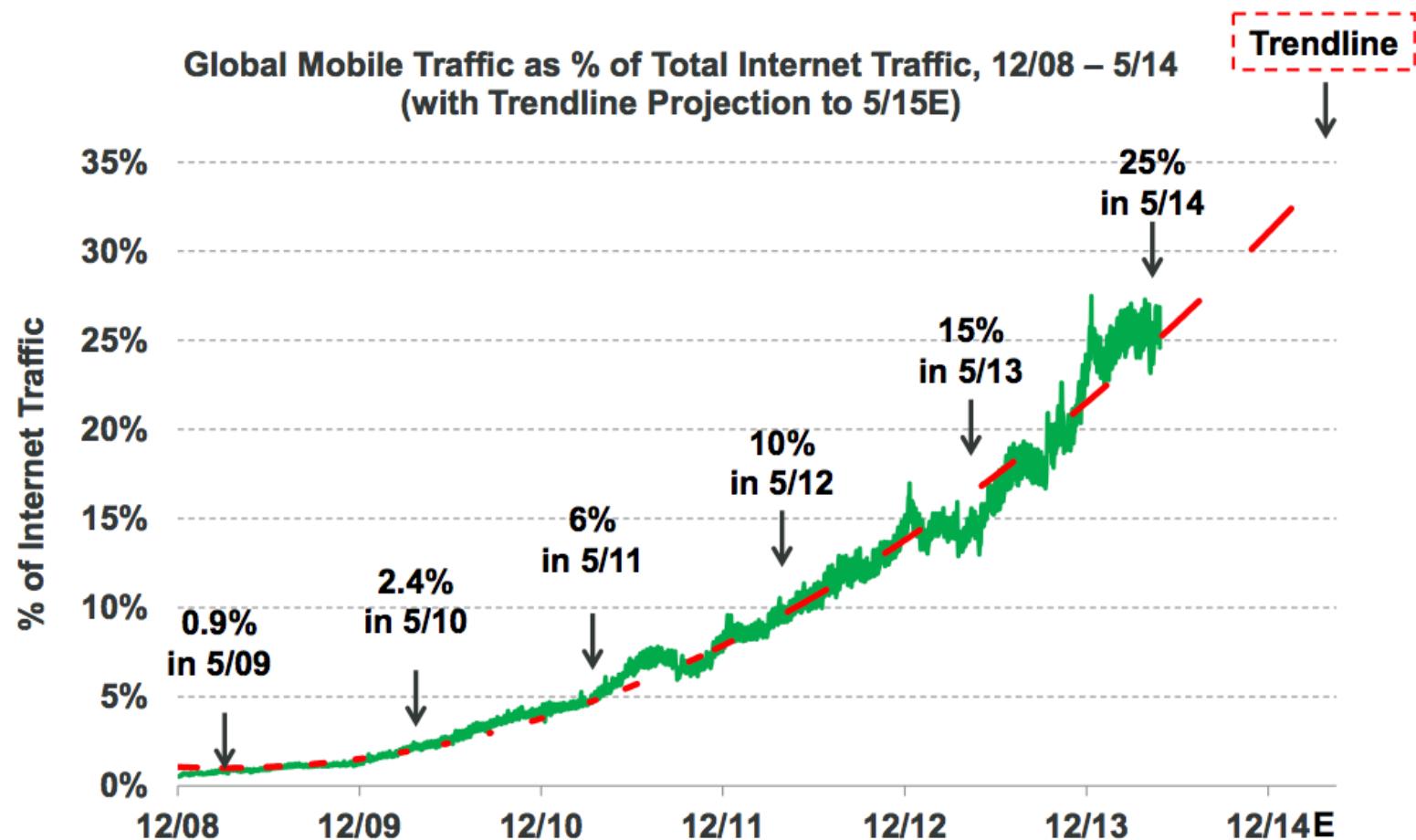


Source: Frank N. Magid Associates, "Facebook Fatigue - Fact or Fiction?", March 2013.
Based on a study of 2K social media users aged 12-64 who were asked "Which of the Following Social Media Do You Use?"
2011 Pinterest and Instagram data from 9/12 / 4/12.

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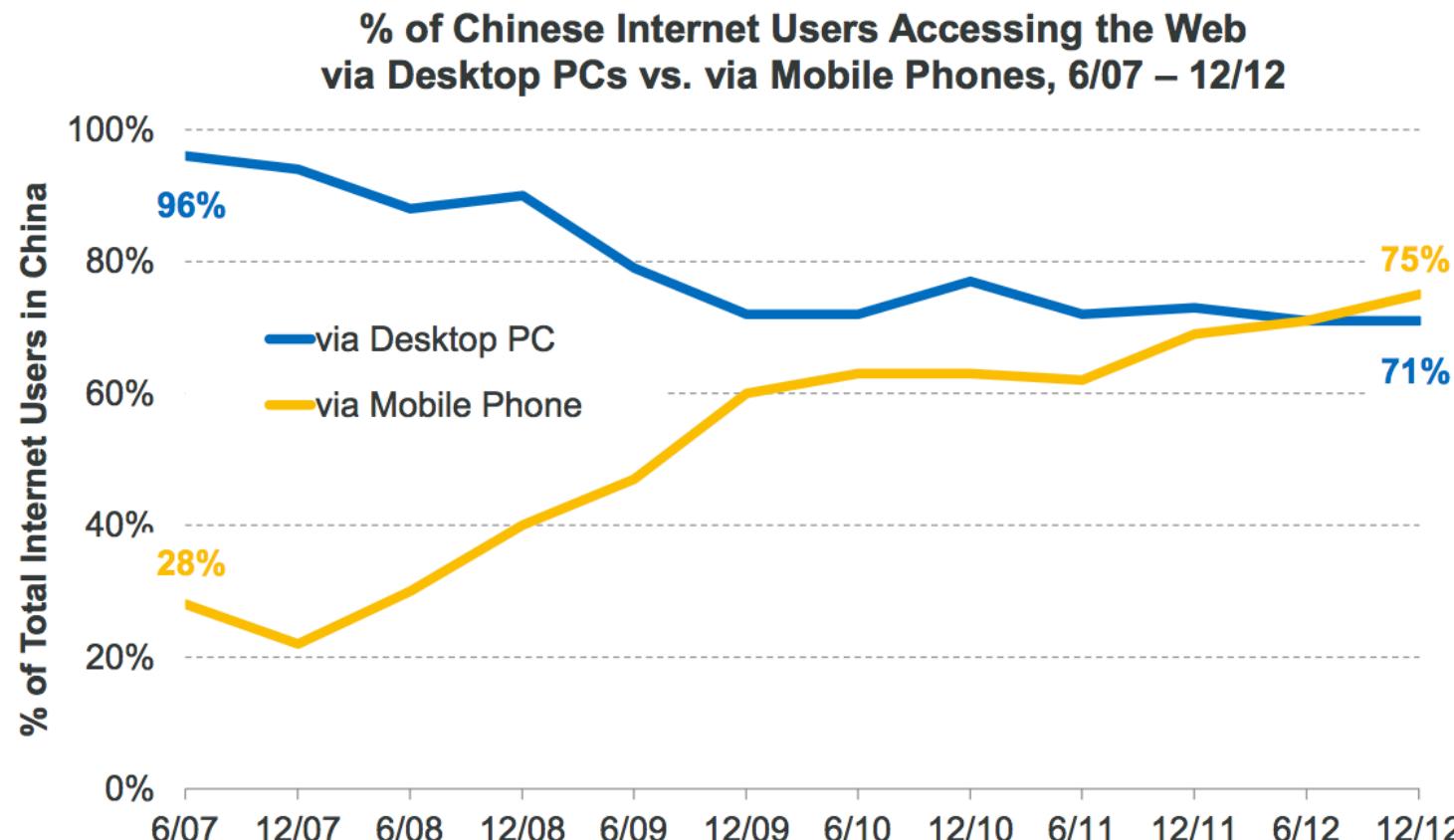
Mobile Traffic as % of Global Internet Traffic =
Growing >1.5x per Year & Likely to Maintain Trajectory or Accelerate



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

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China – Mobile Internet Access Surpassed PC, Q2:12

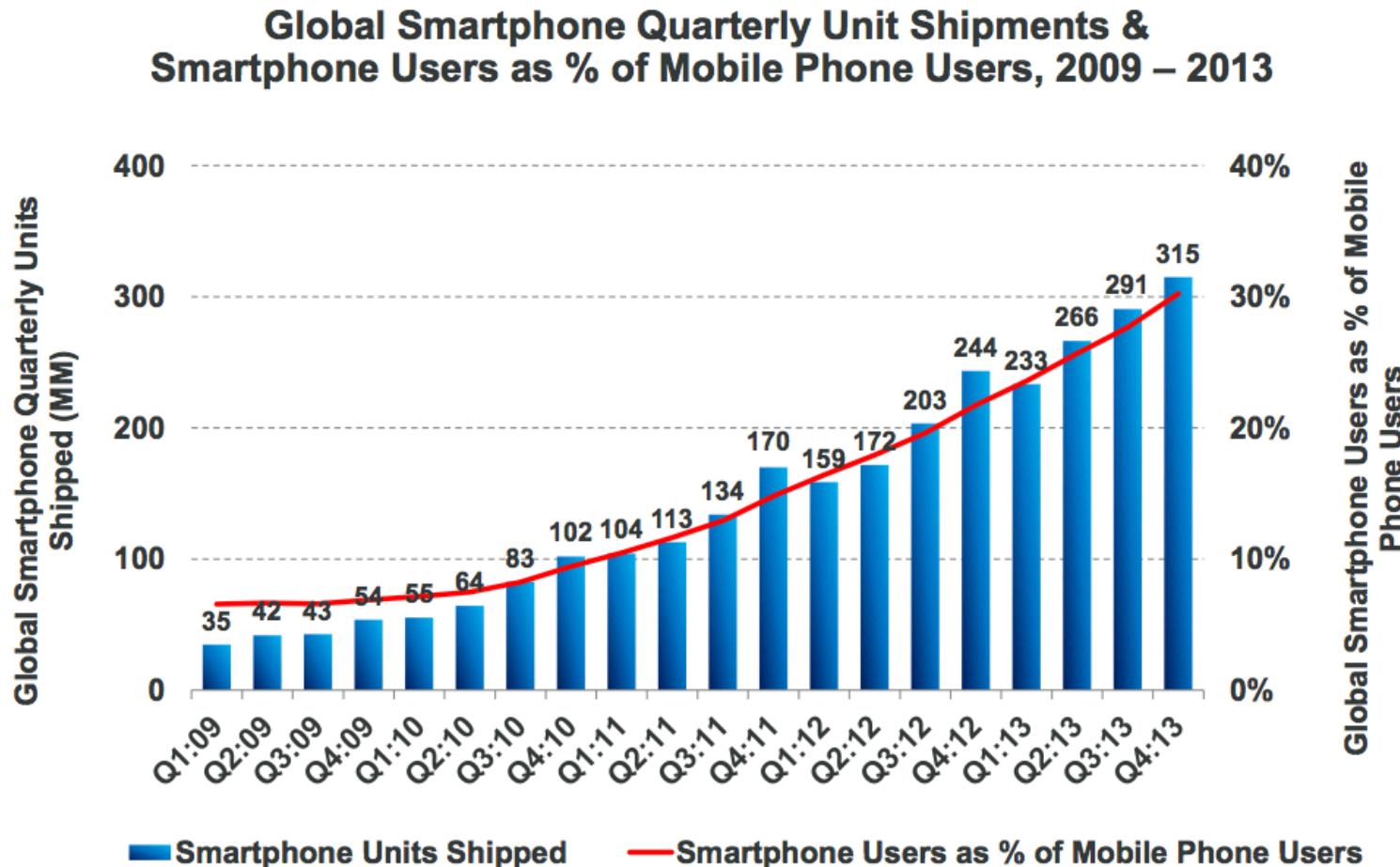


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Source: CNNIC, 1/13.

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Smartphone Users = Still Lots of Upside... @ 30% of 5.2B Mobile Phone User Base



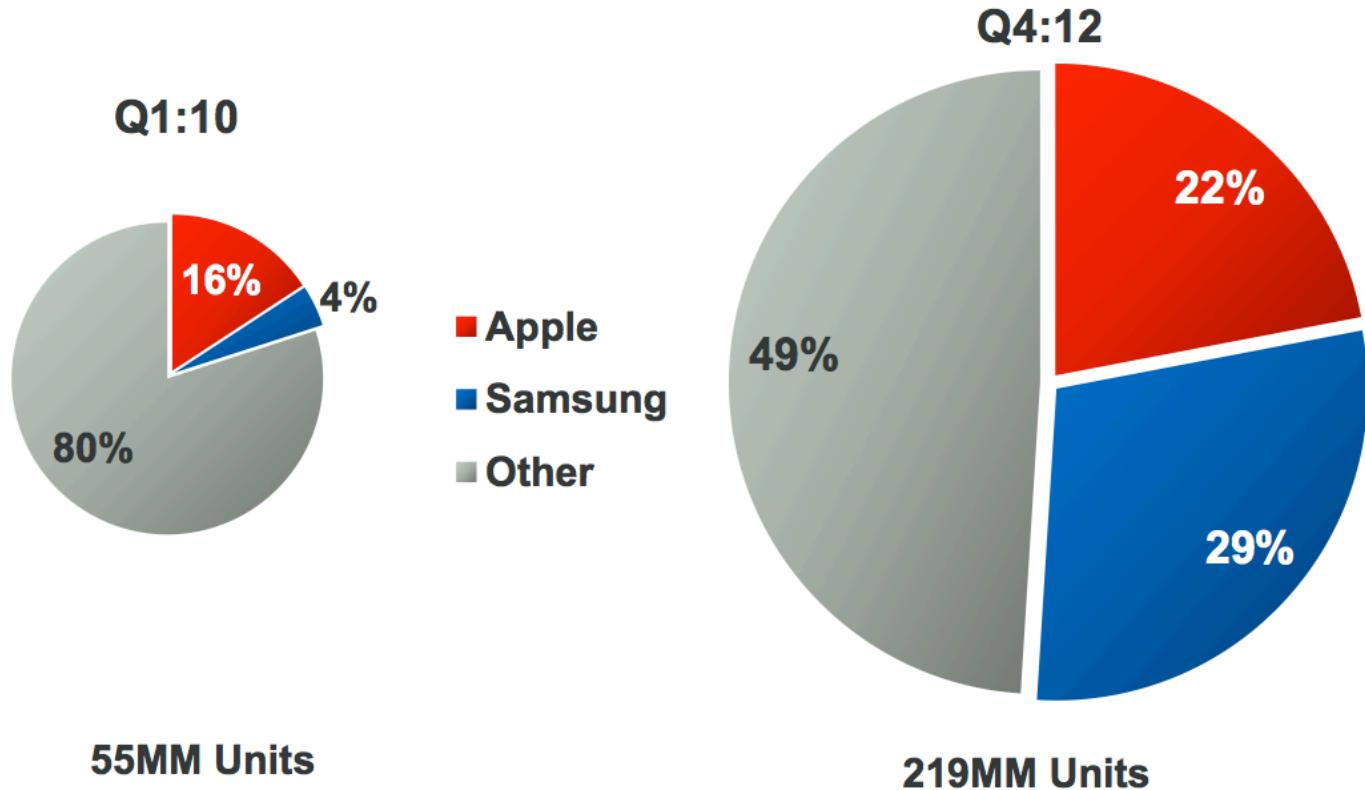
@KPCB

Source: Smartphone shipments per Morgan Stanley Research. User base per KPCB estimates based on Morgan Stanley Research and ITU data. Smartphone users & mobile phone users represent unique individuals owning mobile devices, as noted on slide 8; Mobile Subscribers based on number of connections & may therefore overstate number of mobile users.

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Apple Growing Rapidly (1.4x Share Gain) Samsung Up 7x Over ~2 Years

Global Smartphone Unit Market Share



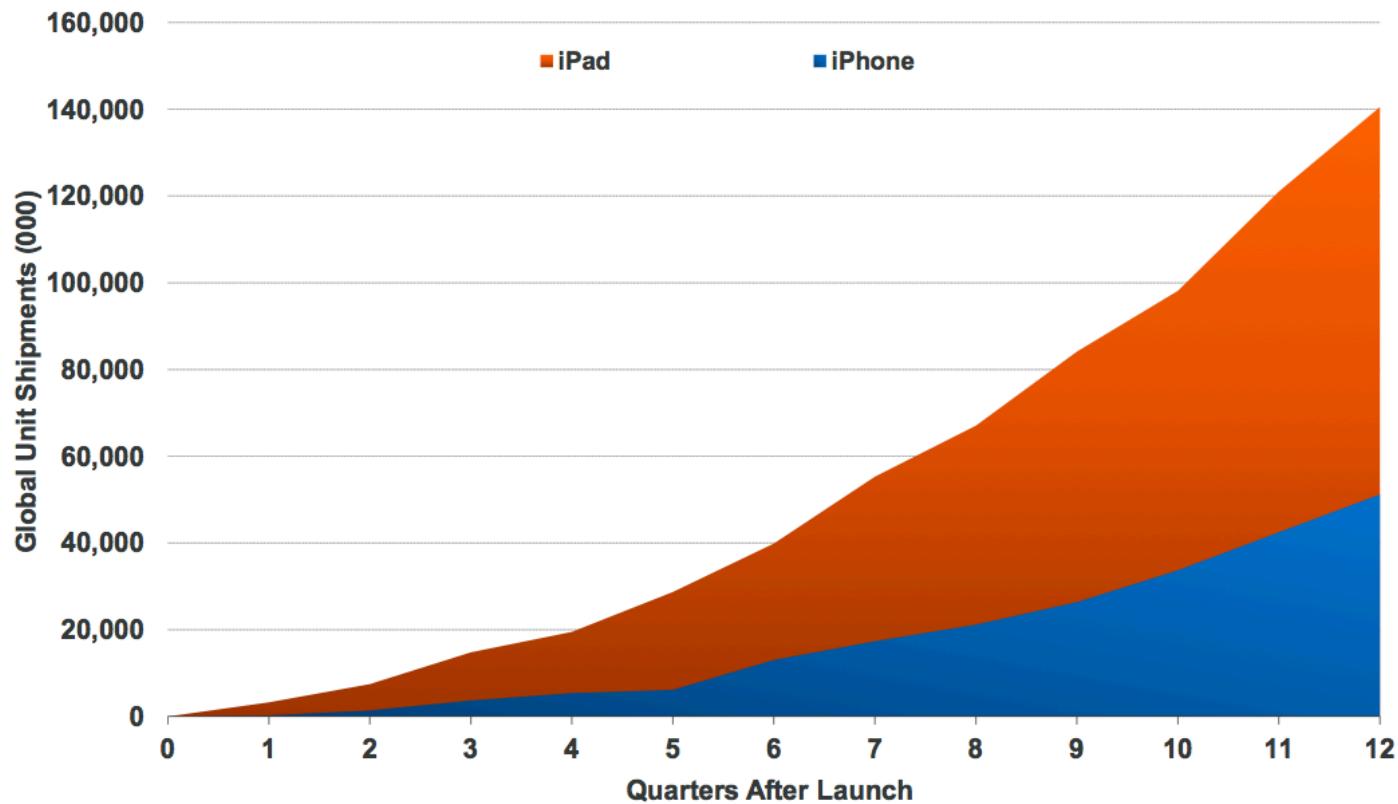
KPCB

Source: IDC, Morgan Stanley Research. Data as of 4/13.

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

First 12 Quarters Cumulative Unit Shipments, iPhone vs. iPad

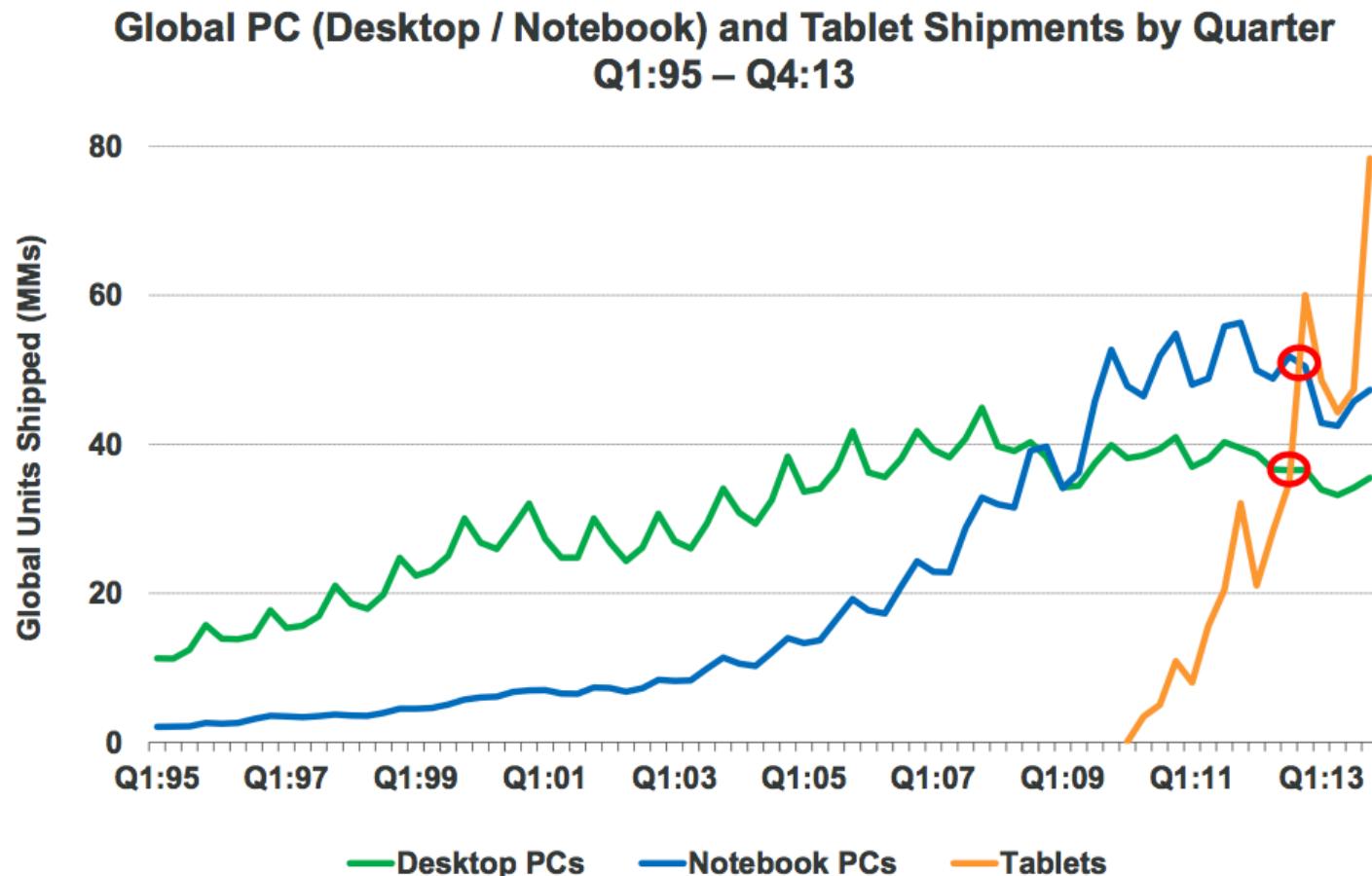


Source: Apple, as of CQ1:13 (12 quarters post iPad launch).
Launch Dates: iPhone (6/29/07), iPad (4/3/10).

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



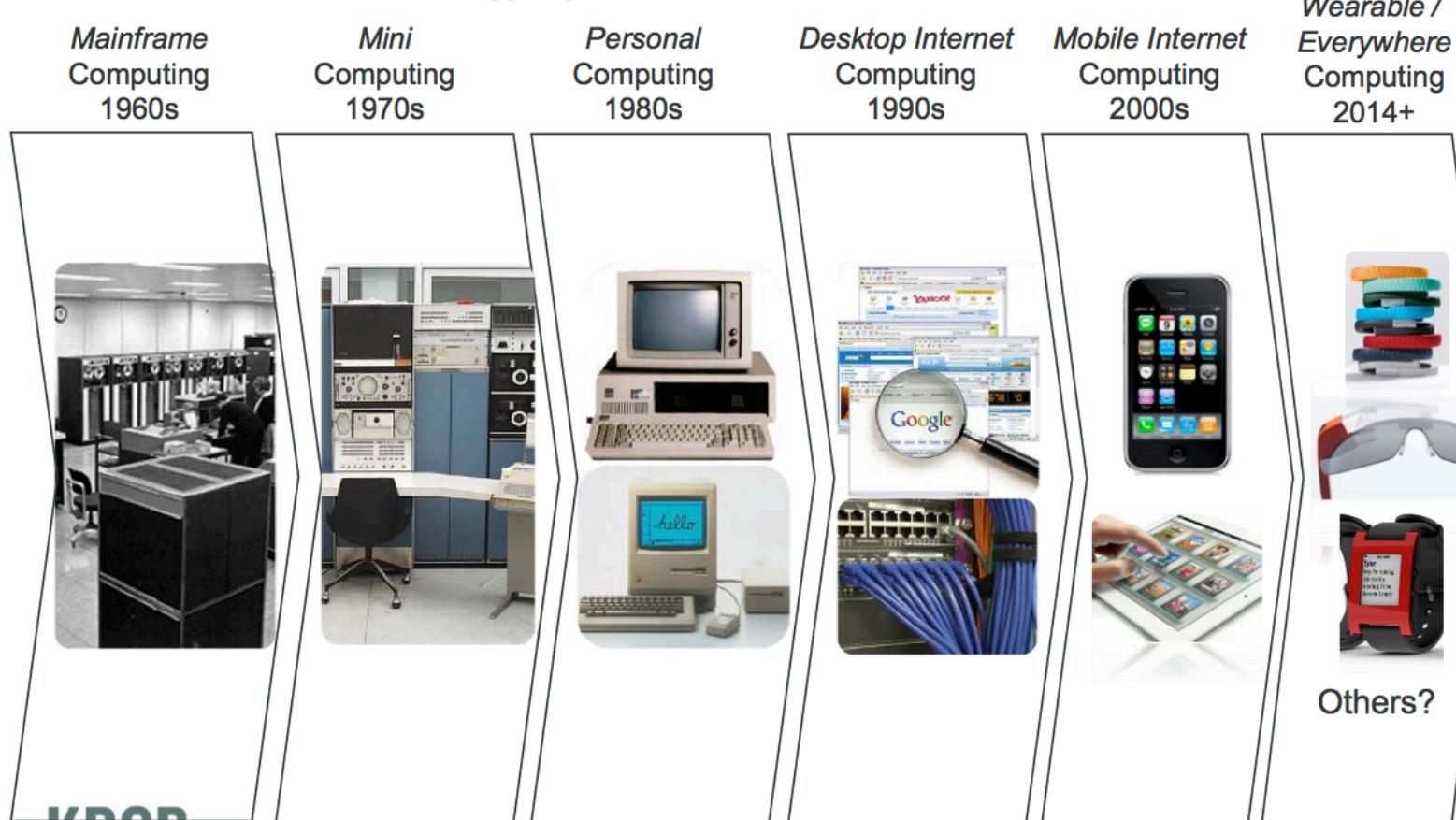
@KPCB

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

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

Technology Cycles Have Tended to Last Ten Years



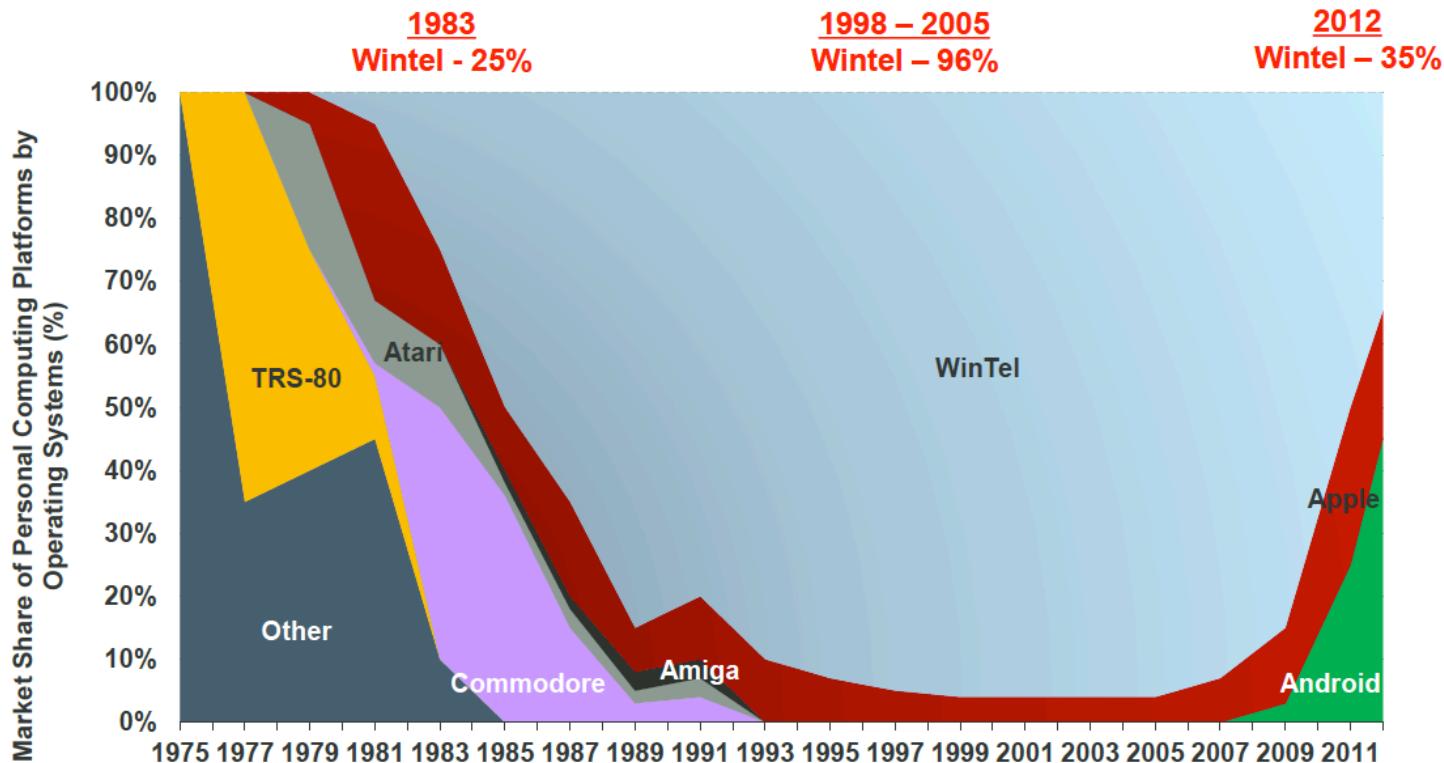
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Image Source: Computersciencelab.com, Wikipedia, IBM, Apple, Google, NTT docomo, Google, Jawbone, Pebble.

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

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



KPCB

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

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...While The Cloud Rises

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

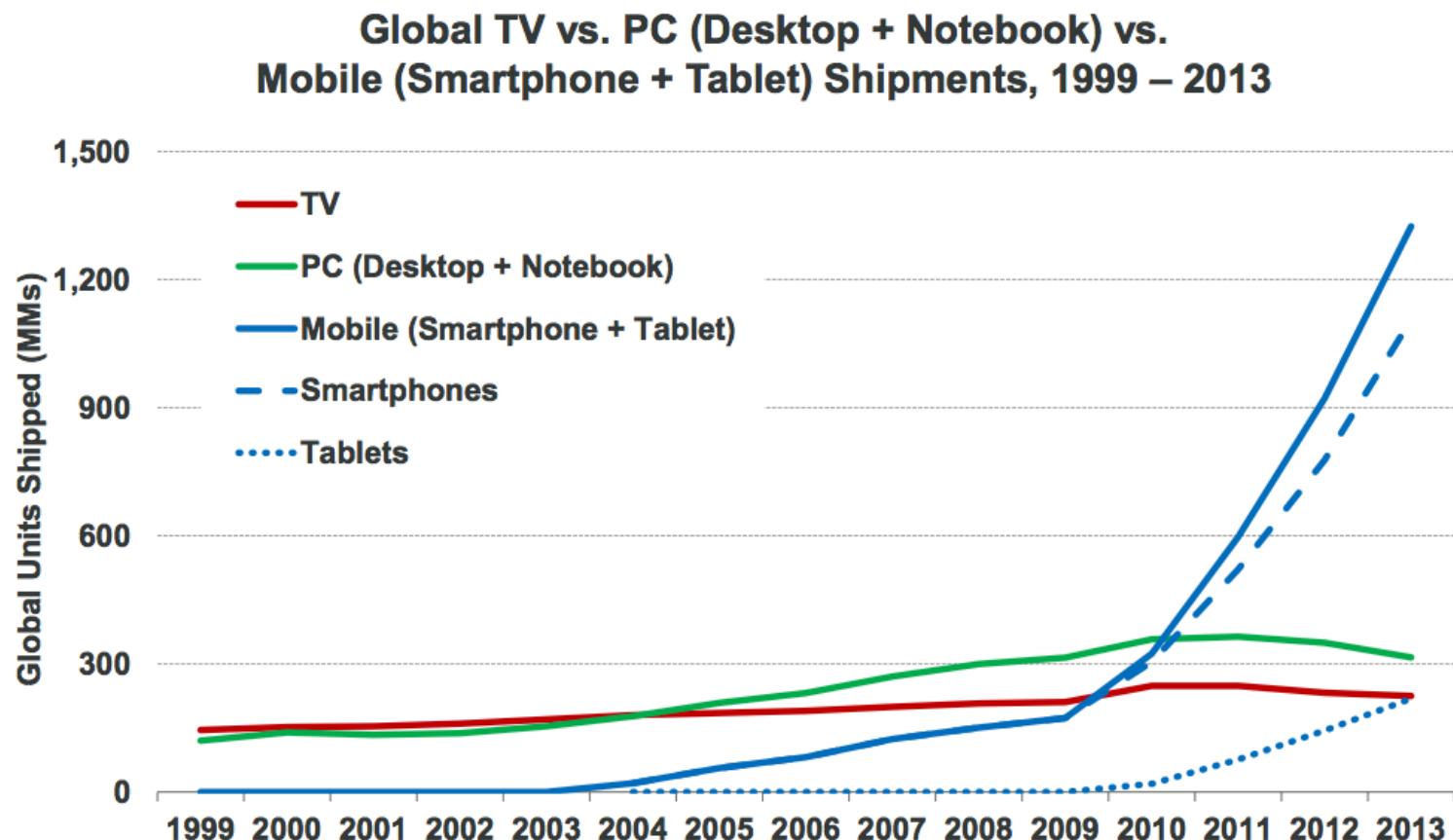


*Note: S3 is AWS' storage product and used as proxy for AWS scale / growth .
Source: Company data.



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



@KPCB

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

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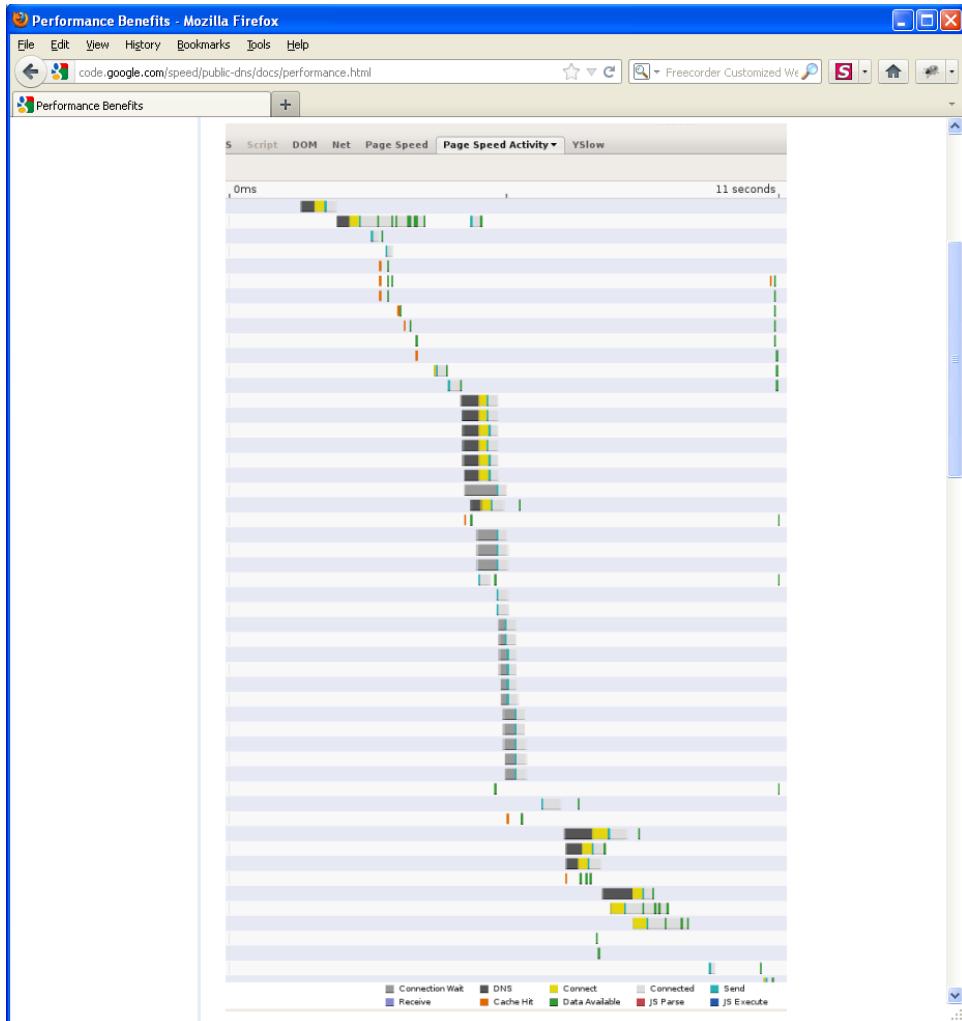
Domain Name System

- 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



- The chart shows the times spent loading a page where
 - black represents DNS resolution,
 - Gray represents Connection waiting,
 - Yellow represents connection,
 - red is JavaScript parsing, and
 - blue is JavaScript execution.
- There are 13 calls to the DNS resolver and 5 of them are serial lookups accounting for several seconds of the total 11 seconds spent loading the page

<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, July 2014,
at <http://ftp.isc.org/www/survey/reports/2014/07/bynum.txt>

Domain	Hosts =	All Hosts	- Dup Names	Level 2 Domains	Level 3 Domains	
TOTAL	1028544414	1104903410	76358996	5037398	135758632	
net	388641779	399646328	11004549	390691	67364917	Networks
com	159689004	194201321	34512317	2805216	25155422	Commercial
jp	75627790	75005737	177947	52073	856221	Japan
br	4234114	42921268	610044	560	181475	Brazil
de	34003061	34993539	190878	179979	5269571	Germany
it	26306094	26372099	66005	30172	811301	Italy
cn	20923527	22821686	1898159	6075	16695	China
mx	18414459	19720517	1306058	1699	118189	Mexico
au	16043351	16189747	145396	84	95727	Australia
fr	15869141	15990761	121620	36641	652318	France
ru	14685829	15454580	768751	97305	3773992	Russian Federation
ar	14459566	14695815	236249	43	14232	Argentina
nl	14214400	14474100	259700	68494	3439744	Netherlands
pl	13283130	13378663	95533	22742	2363436	Poland
edu	12153403	12589978	436575	9593	3828690	Educational
ca	9407329	9801033	393704	37713	1208018	Canada
uk	7312158	8436645	1124487	170	118279	United Kingdom
tr	7069155	7098691	29536	30	8287	Turkey
in	6698944	6825862	126918	9672	57410	India
tw	6631999	6694077	62078	1408	29844	Taiwan, Province Of China
se	5891385	5978710	87325	16296	442826	Sweden
co	5652458	5989287	336829	5692	28820	Colombia
be	5348310	5382123	33813	21099	285416	Belgium
ch	5263592	5374663	111071	28976	1596798	Switzerland
fi	4455207	4486268	31061	15034	2040243	Finland
es	4184565	4353721	169156	12754	567654	Spain
pt	3820063	381871	11808	7081	312107	Portugal
th	3695931	3708827	12896	14	4309	Thailand
at	3617337	3655405	38068	26539	386627	Austria
cz	3529089	3567679	38590	24923	1073622	Czech Republic
za	3497732	3613497	115765	59	23127	South Africa
no	3383603	3418798	35195	13701	295608	Norway
gr	3376899	3385242	8343	8881	97446	Greece
cl	3334321	3421168	86847	10753	62424	Chile
hu	3326658	3341413	14755	17061	694095	Hungary
nz	3050023	3090066	40043	24	22388	New Zealand
eg	2961878	2977230	15352	26	879	Egypt
arpa	2851040	4000560	1149462	27	12212	Mistakes
ro	2809554	3052879	243325	25488	2033722	Romania
mil	2663608	4914870	2251262	194	104214	US Military
ua	2615122	2828336	213214	2217	148346	Ukraine
il	2488248	2535086	46840	20	11270	Israel
dk	2461572	2507410	45838	16993	174392	Denmark
gov	2270128	3327005	1056877	2053	675722	Government
sg	2124349	2136742	12393	903	8580	Singapore
org	2106645	2308954	202309	271636	1343216	Organizations
us	2045493	2170239	124746	24929	109650	United States
id	1911571	1954426	42855	29	6035	Indonesia
uy	1579074	1582100	3026	31	1670	Uruguay
ie	1517619	1528206	10587	8800	285855	Ireland
sk	1333260	1339110	5850	6418	407849	Slovakia (Slovak Republic)
ir	1329683	1331253	1570	897	1242663	Iran (Islamic Republic Of)
...	13282170	13282170	1570	77	77	...

Top-level Domains (TLDs) Overview

For the day of **January 10, 2015**

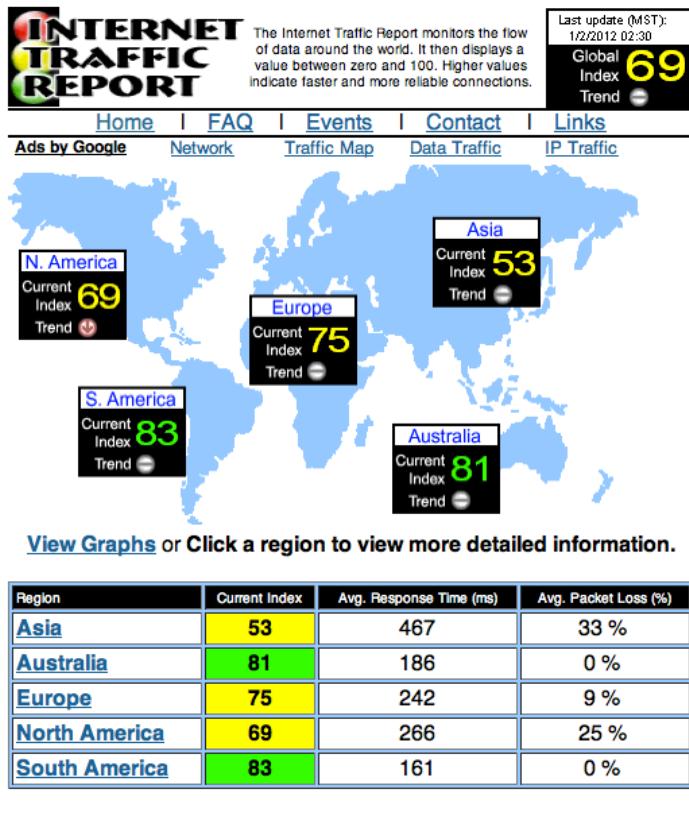
TLD	New	Deleted	Transferred	Current Total
.COM	115,413	91,139	122,878	116,375,069
.NET	13,052	11,702	14,788	15,120,348
.ORG	7,113	6,105	9,359	10,536,896
.INFO	7,221	6,238	6,406	5,499,413
.BIZ	1,972	3,387	2,685	2,381,838
.US	1,508	2,023	1,119	1,818,418
TOTALS	146,279	120,594	157,235	151,731,982

Above shows 115 million .com sites out
Of a total 146 million; see
<http://www.dailychanges.com>

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

The screenshot shows a browser window displaying a NetFlow report for the week of 20100426. The title bar says "NetFlow report for the week of 20100426". The page content includes two tables: Table 6. Aggregated Application Types (Full Data Set) and Table 7. Detailed Application Types (Full Data Set).

Table 6. Aggregated Application Types (Full Data Set)

Type	Octets	Packets
Data Transfers	39.08% 713.6T	41.40% 1,002T
Encrypted Traffic	5.25% 95.8T	5.94% 143.7G
Measurement	2.76% 50.30T	2.23% 53.90G
File Sharing	1.96% 35.71T	1.56% 37.69G
Advanced Apps	1.73% 31.54T	1.48% 35.73G
Misc	1.65% 30.08T	3.46% 83.82G
Audio/Video	0.52% 9.465T	0.43% 10.29G
Games	0.23% 4.241T	0.38% 9.141G
Unidentified	46.83% 855.1T	43.14% 1,045T
Total	100.00% 1.82P	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

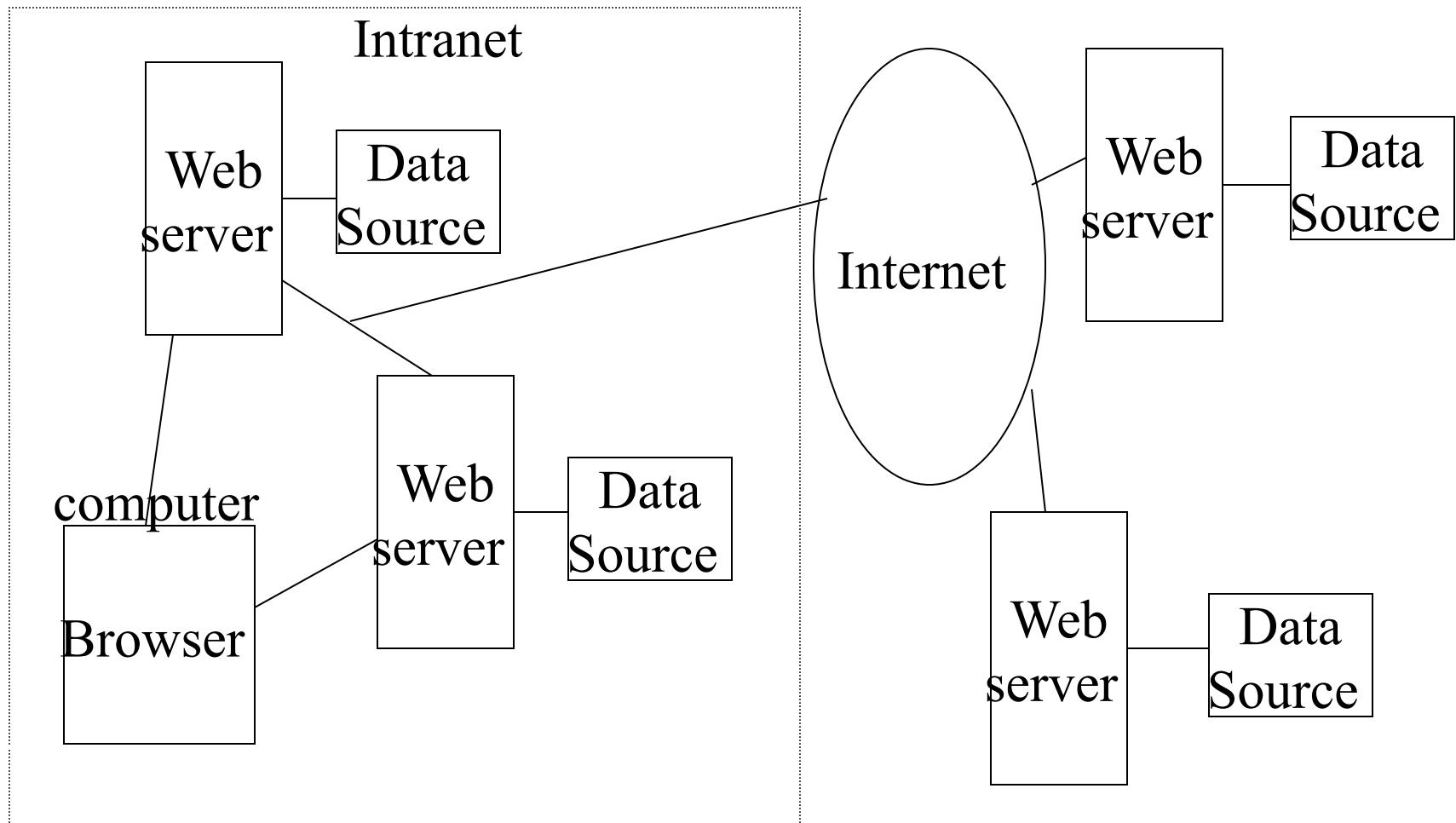
In April 2010:
Data Transfers was 41%

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

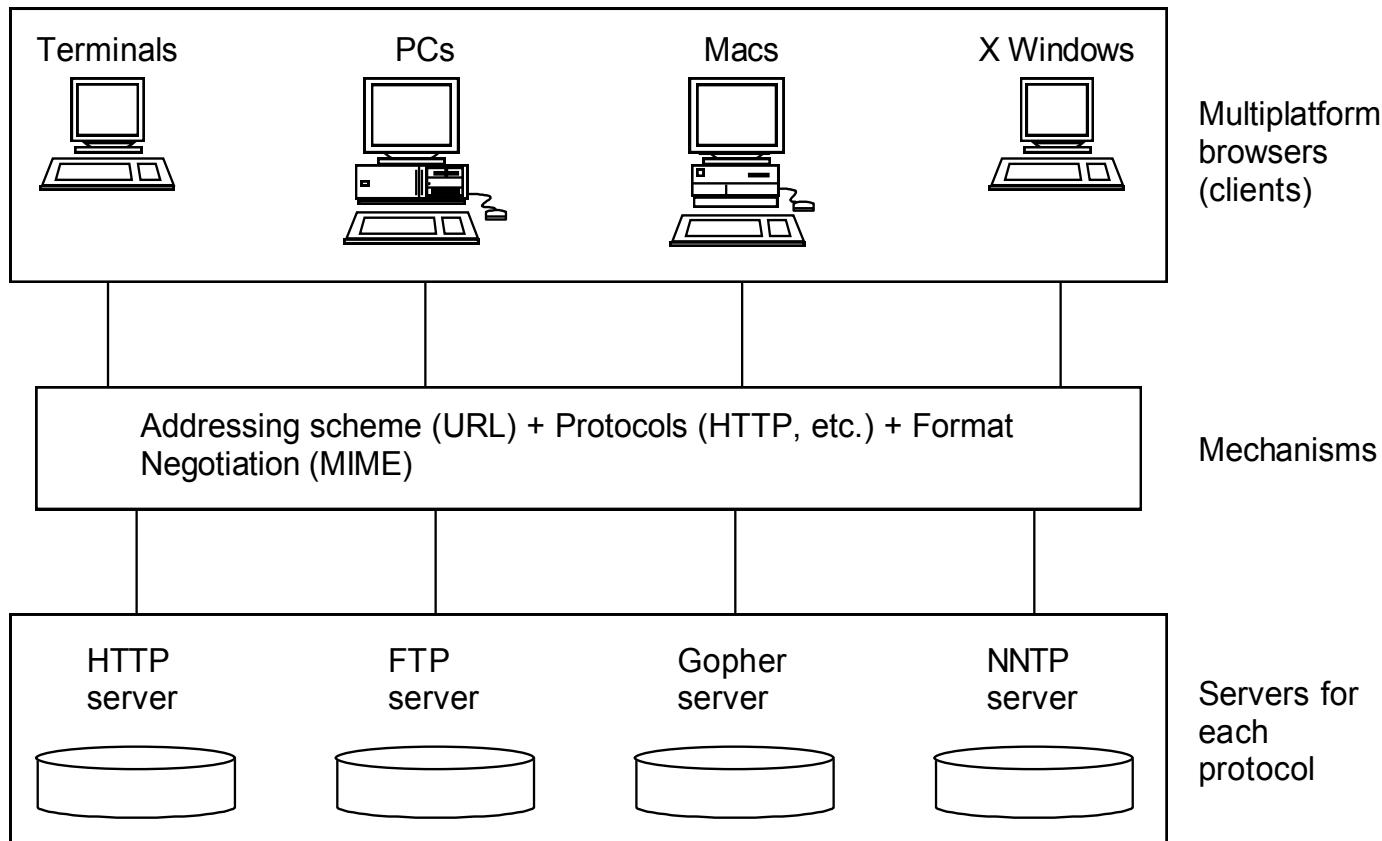
Graphical View of the WWW



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

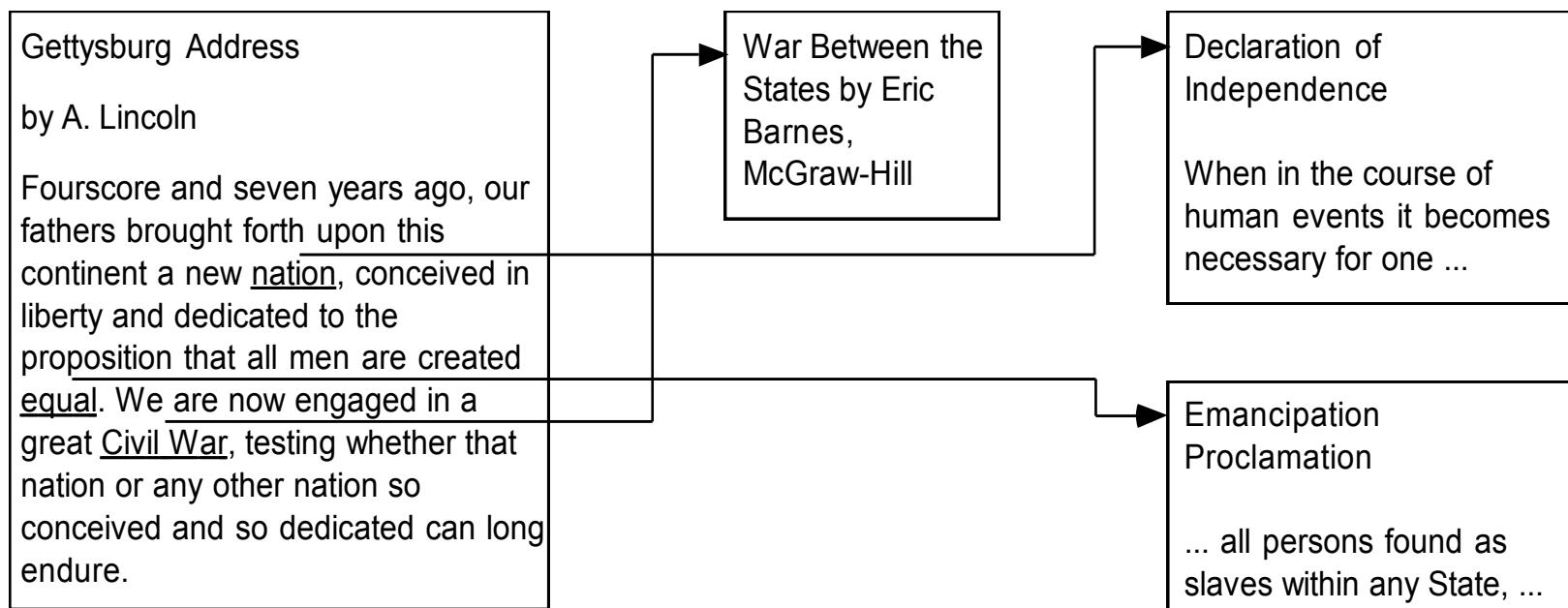
~	%7E		%7C
SPACE	%20	\	%5C
%	%25	^	%5E
&	%26	[%5B
=	%3D]	%5D
?	%3F	#	%23
{	%7B	>	%3E
}	%7D	<	%3C

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

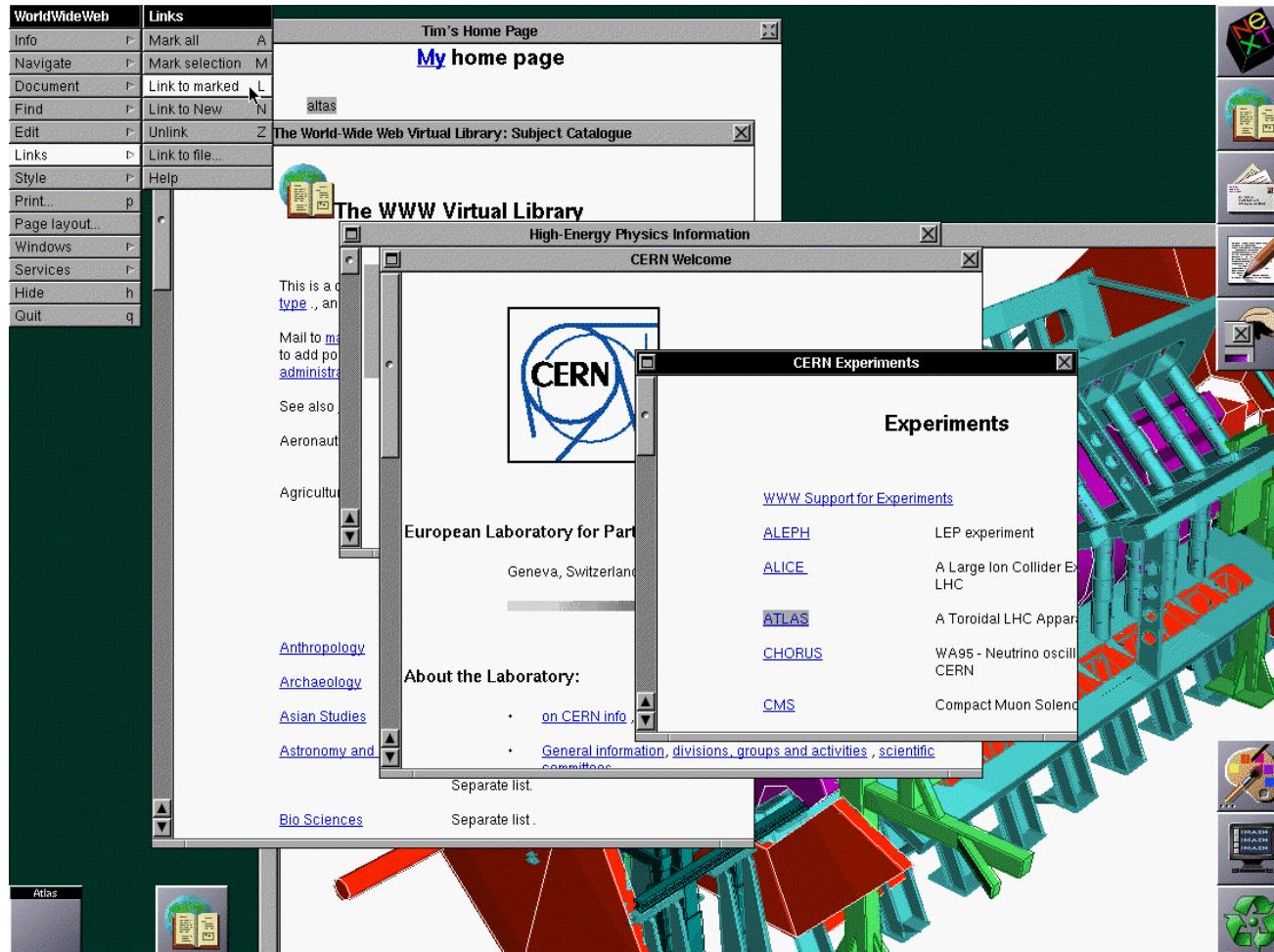


Early History of the WWW

- 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
World Wide Web Consortium formed
- 1995 Microsoft Windows 95 and Internet Explorer 1.0 released
- 1995 Java is released
- 1998 Google is started
- 1999-2001 A burst of Internet start-up companies which
flamed out because they were not profitable
- 2004 Firefox 1.0 is released
- 2005 YouTube is founded
- 2008 Google Chrome 1.0 is released

First Web Communication (Dec 1990)

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



WWW Consortium

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