



The Beauty and Joy of Computing

Lecture #15
Internet I

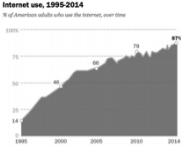


UC Berkeley EECS
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Web turns 25 ⇒
In 1989, Sir Tim Berners-Lee sat in an office in CERN and developed the WWW. Celebrate: #web25
bits.blogs.nytimes.com/2014/03/11/as-the-world-wide-web-turns-25-fear-about-its-future

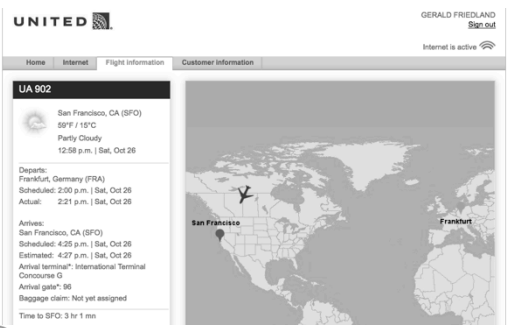


Internet use, 1995-2014
% of American adults who use the Internet, over time



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Internet is pretty much everywhere!



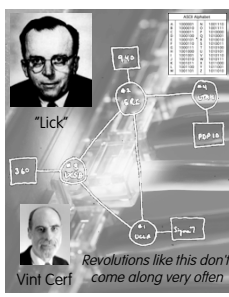
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www.computerhistory.org/internet_history

The Internet (1962)

- Founders
 - JCR Licklider, as head of ARPA, writes on "intergalactic network"
 - 1963 : ASCII becomes first universal computer standard
 - 1969 : Defense Advanced Research Projects Agency (DARPA) deploys 4 "nodes" @ UCLA, SRI, Utah, & UCSB
 - 1973 Robert Kahn & Vint Cerf invent TCP, now part of the Internet Protocol Suite
- Internet growth rates
 - Exponential since start!



Revolutions like this don't come along very often

www.greatachievements.org/?id=3736
en.wikipedia.org/wiki/Internet_Protocol_Suite

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The basics of the basics

http://youtu.be/7_LPdtKXPC

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The Internet Today




Internet Usage as a Percentage of Population (2012)
Source: Wikimedia Commons

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Growth of the Internet

- The major point in building networks is agreement.
- The Internet was built
 - using a decentralized architecture
 - using open protocols



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Properties of the Internet: Decentralization

To remove nodes: unplug them!

Source: BJC Spring 12, Lecture 17
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Properties of the Internet: Open Standards

- Internet Engineering Task Force (IETF):
 - Request for Comments (RFC)
- World Wide Web Consortium (W3C)
 - HTML
- International Standards Organization (ISO)
 - JPEG, MPEG
- Institute of Electrical and Electronics Engineers (IEEE)
 - WiFi

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Email (1965)

en.wikipedia.org/wiki/Email

- Fundamentally changed the way people interact!
- 1965: MIT's CTSS
 - Compatible Time-Sharing Sys
- Exchange of digital info
 - Model: "Store and Forward"
 - "Push" technology
- Pros
 - Solves logistics (where) & synchronization (when)
- Cons
 - "Email Fatigue"
 - Information Overload
 - Loss of Context

How

- Alice composes email to bob@b.org
- Domain Name System looks up where b.org is
- DNS server with the mail exchange server for b.org
- Mail is sent to mx.b.org
- Bob reads email from there

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The World Wide Web (1989)

en.wikipedia.org/wiki/History_of_the_World_Wide_Web

- "System of interlinked hypertext documents on the Internet"
- History
 - 1945: Vannevar Bush describes hypertext system called "memex" in article
 - 1989: Tim Berners-Lee proposes, gets system up '90
 - ~2000 Dot-com entrepreneurs rushed in, 2001 bubble burst
- Wayback Machine
 - Snapshots of web over time
- Today: Access anywhere!

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WWW Search & Browser (1993)

en.wikipedia.org/wiki/History_of_the_web_browser

- Browser
 - Marc L. Andreessen and Eric J. Bina @ NCSA create Mosaic, 1st popular WWW browser
 - First Internet "Killer App"
 - Later: Netscape Navigator
 - Now IE (23%), Firefox (30%)
- Search
 - Before engines, there was a complete list of all servers!
 - 1993 Martijn Koster Aliweb is 1st web search engine
 - 1997 Stanford Sergey Brin and Larry Page develop Google's search, based on PageRank (each: \$16 Billion)

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Web 2.0: The Social Network (2004)

en.wikipedia.org/wiki/Web_2.0

- "...web development & design that facilitates interactive information sharing, interoperability, user-centered design and collaboration on WWW"
 - Users change content via "architecture of participation"
- Examples
 - Web communities, apps, social networks, video & photo sharing, wikis, blogs, tweets, ...
- "Take back the web!"
 - "You" – Time's 2006 Person of the Year

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IP Addresses

An IPv4 address (dotted-decimal notation)

172 . 16 . 254 . 1

↓ ↓ ↓ ↓

10101100.00010000.11111110.00000001

One byte=Eight bits

Thirty-two bits (4 x 8), or 4 bytes

- Split: First part network, second part computer indicated by /bits: e.g. 192.168.1.103/16
- $2^{32} = 4$ billion unique numbers (world population 7 billion)

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Problem: No more IP addresses left...

Free /8

IANA RIR pool + IANA

Source: Wikimedia Commons

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Solution: IPv6

An IPv6 address (in hexadecimal)

2001:0DB8:AC10:FE01:0000:0000:0000:0000

↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

2001:0DB8:AC10:FE01::

Zeros can be omitted

1000000000000100110111000101010001000011111100000001

00

- $2^{128} = 3.403 \times 10^{38}$ unique addresses
- Issue: Adoption still in progress
- Workaround exists: NAT (Network Address Translation)

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Summary and Outlook

- The Internet is setup for growth using open standards
- It is highly failure tolerant due to decentralization
- However, issues arise with trying to improve it.

Internet II (Wednesday):

- Routers
- Internet Protocols
- Vulnerabilities of the Internet
- More on Social Implications

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