

*bjc*

**Jonathan  
McKinsey**



# The Beauty and Joy of Computing

## Lecture #13 Internet I



### Jon's Recipe for Success in College (and Beyond)

- Form study groups. Learn from and teach your peers.
- Get a github account and start building your portfolio.
- Learn the difference between confidence and arrogance.
- Be thinker and not a drone.
- Exercise and eat right.
- Stay up-to-date in your field. Join professional societies.
- Give back to the community.



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# Internet History

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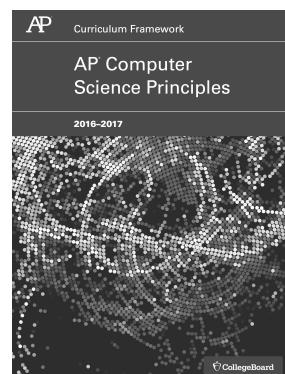
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# (AP) Computer Science Principles

### 7 Big Ideas

- Creativity
- Abstraction
- Data and Information
- Algorithms
- Programming
- The Internet
- Global Impact



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# Internet is pretty much everywhere! (1/2)

UNITED

GERALD FRIEDLAND  
Sign out

Internet is active

UA 902
San Francisco, CA (SFO) 59°F / 15°C Partly Cloudy 12:58 p.m.   Sat, Oct 26
Departs: Frankfurt, Germany (FRA)
Scheduled: 2:00 p.m.   Sat, Oct 26
Actual: 2:21 p.m.   Sat, Oct 26
Arrives: San Francisco, CA (SFO)
Scheduled: 4:25 p.m.   Sat, Oct 26
Estimated: 4:27 p.m.   Sat, Oct 26
Arrival terminal*: International Terminal
Concourse G
Arrival gate*: 96
Baggage claim: Not yet assigned
Time to SFO: 3 hr 1 min



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## Internet is pretty much everywhere! (2/2)

Astronaut using the Internet on the International Space Station



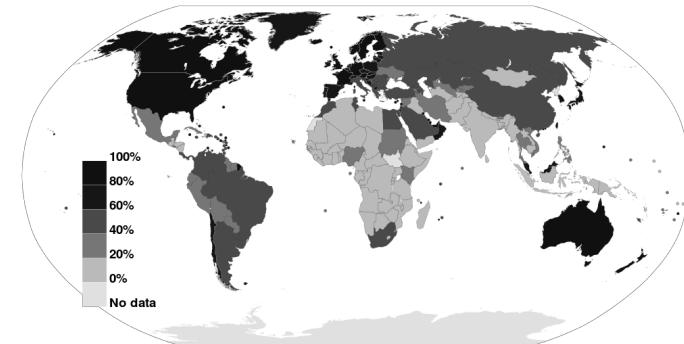
Source: NASA

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## The Internet Today



Internet Usage as a Percentage of Population (2012)

Source: Wikimedia Commons

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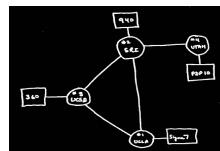
## The Internet (1962)

[en.wikipedia.org/wiki/Internet\\_Protocol\\_Suite](http://en.wikipedia.org/wiki/Internet_Protocol_Suite)  
[www.computerhistory.org/internet\\_history](http://www.computerhistory.org/internet_history)  
[www.greatachievements.org/?id=3736](http://www.greatachievements.org/?id=3736)



Licklider

ASCII Alphabet	
A	1000001
B	1000010
C	1000011
D	1000100
E	1000101
F	1000110
G	1000111
H	1001000
I	1001001
J	1001010
K	1001011
L	1001100
M	1001101
N	1001110
O	1001111
P	1010000
Q	1010001
R	1010010
S	1010011
T	1010100
U	1010101
V	1010110
W	1010111
X	1011000
Y	1011001
Z	1011010



Vint Cerf

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## Quick Question I

In the last 3 years, what was the longest time stretch you have ever been without Internet?

- a) Several hours
- b) 1-2 days
- c) More than 2 days
- d) Several weeks
- e) More than several weeks



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## Quick Question II

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What was the reasons for not having access to the Internet?

- a) Technical interruption
- b) In an area with no Internet
- c) Voluntary break
- d) Didn't bother having access
- e) Other



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## The basics of the basics

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[youtu.be/7\\_LPdttKXpc](https://youtu.be/7_LPdttKXpc)



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# Internet How it Works



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[en.wikipedia.org/wiki/End-to-end\\_principle](https://en.wikipedia.org/wiki/End-to-end_principle)

## It's a Network of Autonomous Systems (1)

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- The Internet and the systems built on it facilitate collaboration.
- The Internet connects devices and networks all over the world i.e. the Internet of Things.
- An end-to-end architecture facilitates connecting new devices and networks on the Internet.
  - This means all the hard work (e.g., checking if a file is corrupted) is done by the endpoints, and the middle network is "dumb", "unreliable", "dynamic"
  - Software-Defined Networking (SDN) and Cloud Computing are changing this!
- Connecting new devices to the Internet is enabled by assignment of an Internet protocol (IP) address.
- The domain name system (DNS) translates names to IP addresses.



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## It's a Network of Autonomous Systems (2)

- The Internet is built on evolving standards, including those for addresses and names.
  - We'll see how IP has changed, new "top-level" domain names added!
- Devices & networks that make up the Internet are connected and communicate using addresses and protocols.
  - Protocols = agreements on standards
- Standards such as hypertext transfer protocol (HTTP), IP, and simple mail transfer protocol (SMTP) are developed and overseen by the Internet Engineering Task Force (IETF).

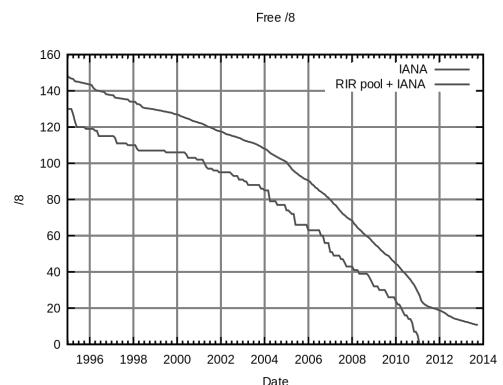


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## Problem: No more IP addresses left...

- 1 global Internet Assigned Numbers Authority (IANA)
- 5 regional Internet registries (RIR)



Source: Wikimedia Commons



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## IP Addresses (this one is called IPv4)

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

- $2^{32} = \sim 4$  billion unique numbers (world population 7 billion)



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## Solution: IPv6

An IPv6 address

(in hexadecimal)

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

↓ ↓ ↓ ↓

2001:0DB8:AC10:FE01:: Zeroes can be omitted

10000000000001:000011011011000:101011000010000:1111111000000001:

0000000000000000:0000000000000000:0000000000000000:0000000000000000

- $2^{128} = 3.403 \times 10^{38}$  unique addresses
- Issue: Adoption still in progress
- Band-aid fix: Network Address Translation



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Take a moment and count: How many Internet-connected devices do you own?

- a) 0
- b) 1
- c) 2-5
- d) 5-10
- e) More than 10



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# Internet Applications



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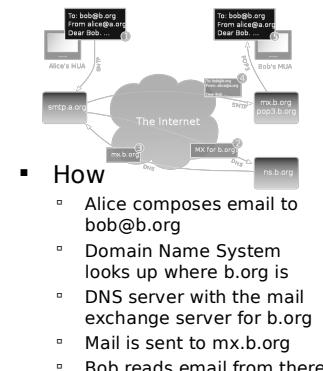
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## Email (1965)

- 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

[en.wikipedia.org/wiki/Email](http://en.wikipedia.org/wiki/Email)



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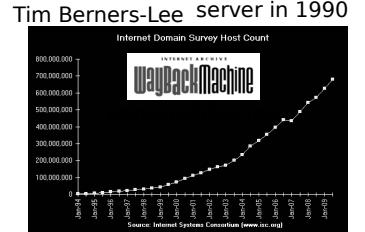
## The World Wide Web (1989)

- "System of interlinked Internet hypertext documents"
- 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!

[en.wikipedia.org/wiki/History\\_of\\_the\\_World\\_Wide\\_Web](http://en.wikipedia.org/wiki/History_of_the_World_Wide_Web)



World's First web server in 1990



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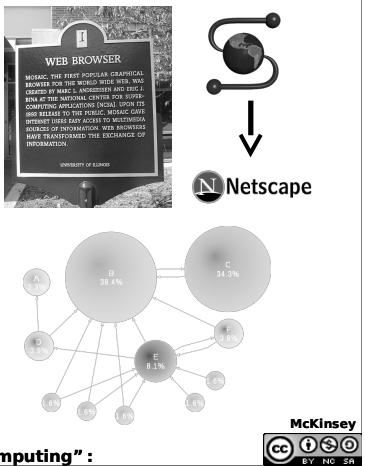


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# WWW Search & Browser (1993)

- Browser

- Marc L. Andreessen and Eric J. Bina @ NCSA create Mosaic, 1<sup>st</sup> popular WWW browser
  - First Internet "Killer App"
  - Later: Netscape Navigator
- Now Chrome, IE, Firefox, Safari, Opera, etc



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# Web 2.0 : The Social Network (2004)

- "...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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