



UC Berkeley EECS
Sr Lecturer SOE
Dan Garcia

The Beauty and Joy of Computing

Lecture #15 Internet I



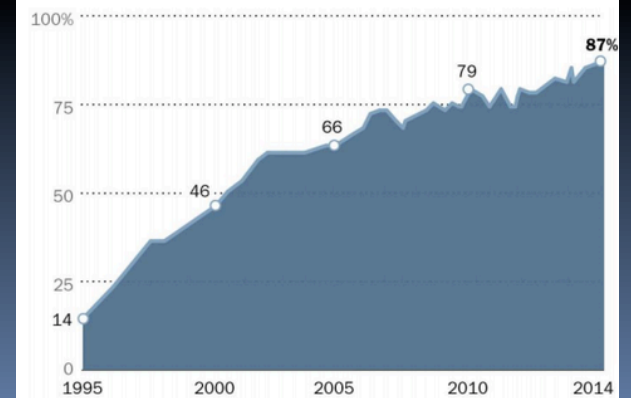
Web
turns
25 ⇒

In 1989, Sir Tim Berners-Lee sat in an office in CERN and developed the WWW. Celebrate: #web25



Internet use, 1995-2014

% of American adults who use the internet, over time



bits.blogs.nytimes.com/2014/03/11/as-the-world-wide-web-turns-25-fear-about-its-future



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





Quick Question II


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






Internet is pretty much everywhere!


UNITED 

GERALD FRIEDLAND
[Sign out](#)

Internet is active 

Home Internet **Flight information** Customer information


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 mn



The map displays the flight route from Frankfurt, Germany to San Francisco, California. A blue airplane icon is positioned over the Atlantic Ocean, indicating the flight path. A red pin marks San Francisco, and a green pin marks Frankfurt.





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!

"Lick"

Vint Cerf

Revolutions like this don't come along very often

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

The diagram shows a network of four nodes: SRI (node #2), UCSB (node #3), Utah (node #4), and UCLA (node #1). Each node is connected to a central hub. Associated with each node is a computer model: 940 for SRI, PDP 10 for Utah, 360 for UCSB, and Sigma 7 for UCLA.

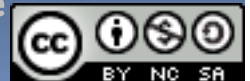
www.greatachievements.org/?id=3736

en.wikipedia.org/wiki/Internet_Protocol_Suite

UC Berkeley "The Beauty and Joy of Computing" : Internet I (5)



Garcia





The basics of the basics



http://youtu.be/7_LPdttKXPc



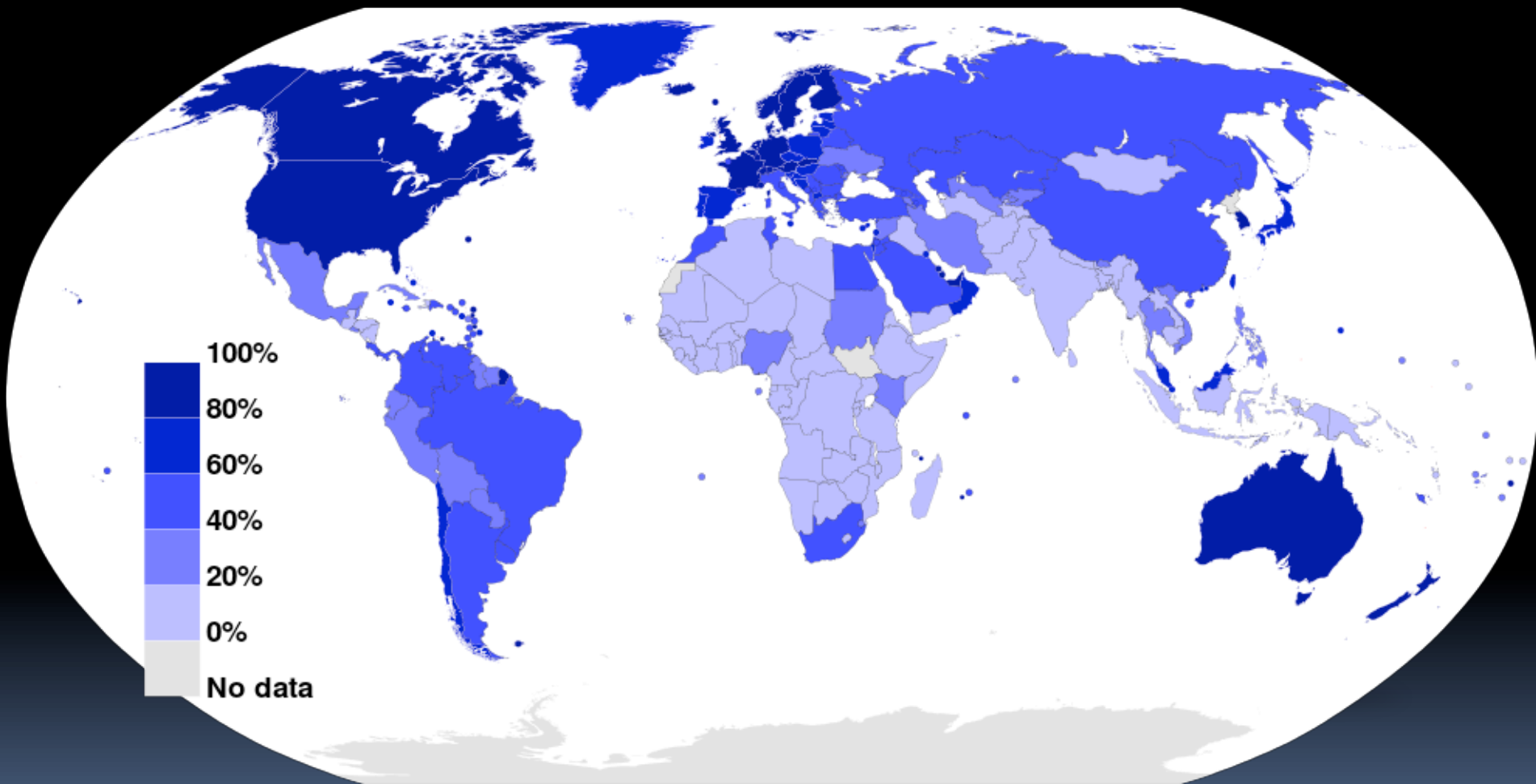
UC Berkeley "The Beauty and Joy of Computing" : Internet I (6)

Garcia





The Internet Today



Internet Usage as a Percentage of Population (2012)

Source: Wikimedia Commons

Garcia





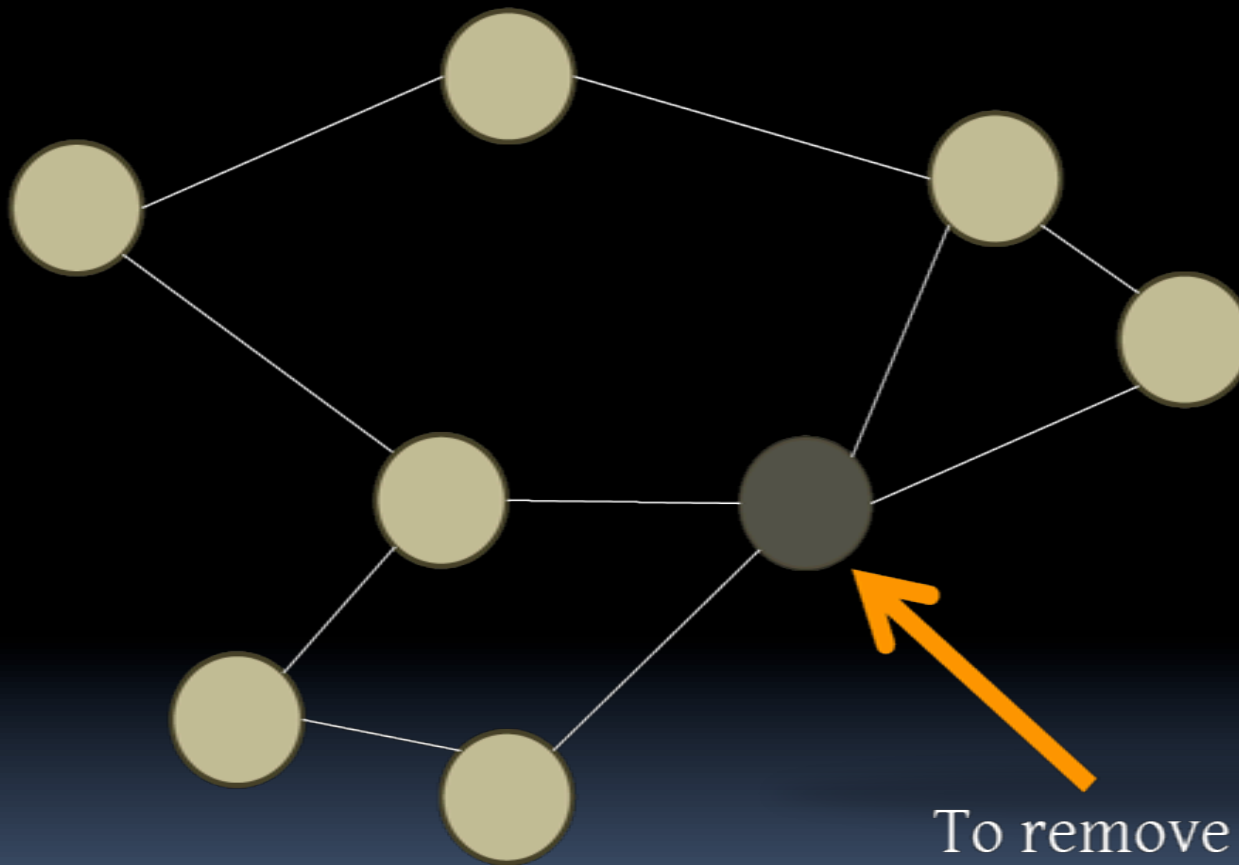
Growth of the Internet

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





Properties of the Internet: Decentralization



To remove nodes:
unplug them!



Source: BJC Spring 12, Lecture 17

UC Berkeley "The Beauty and Joy of Computing" : Internet I (9)

Garcia





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

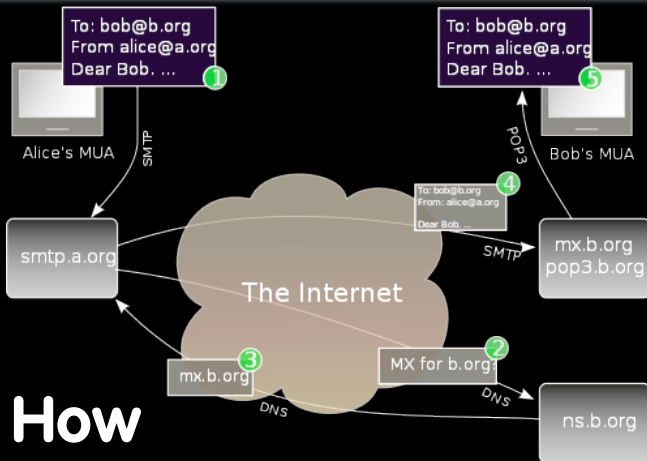




Email (1965)

- **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

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





The World Wide Web (1989)

- “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!

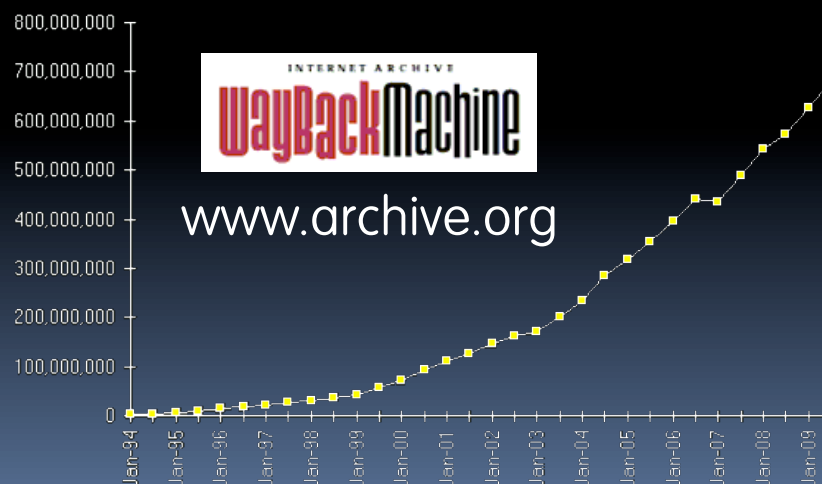


Tim Berners-Lee



World's First web server in 1990

Internet Domain Survey Host Count



Source: Internet Systems Consortium (www.isc.org)

Garcia





WWW Search & Browser (1993)

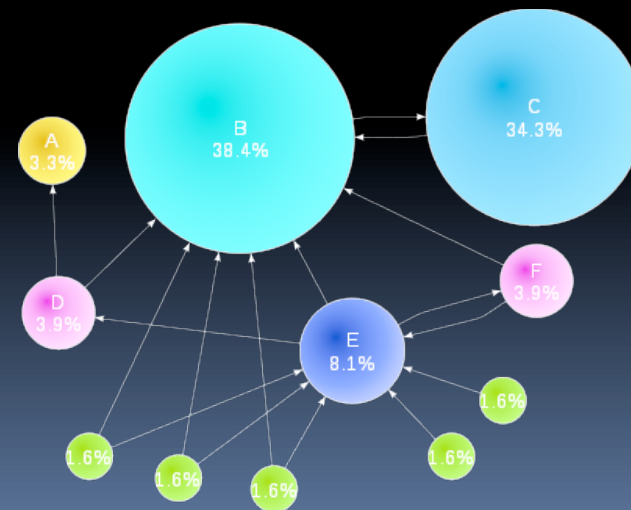
Browser

- 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)



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!"**



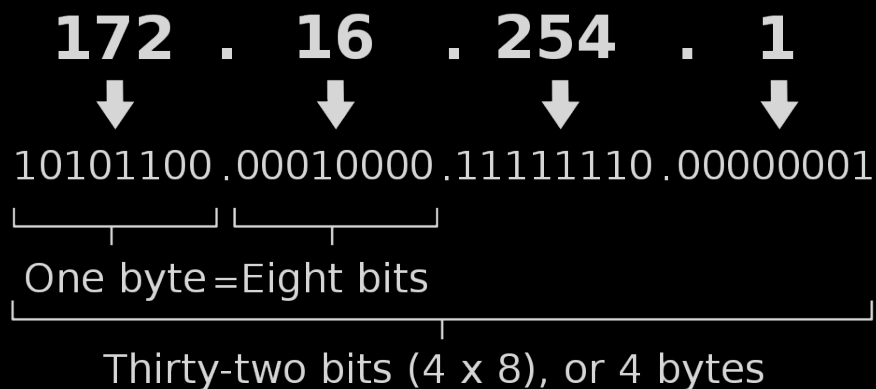
"You" – Time's 2006 Person of the Year





IP Addresses

An IPv4 address (dotted-decimal notation)



- 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)





Count

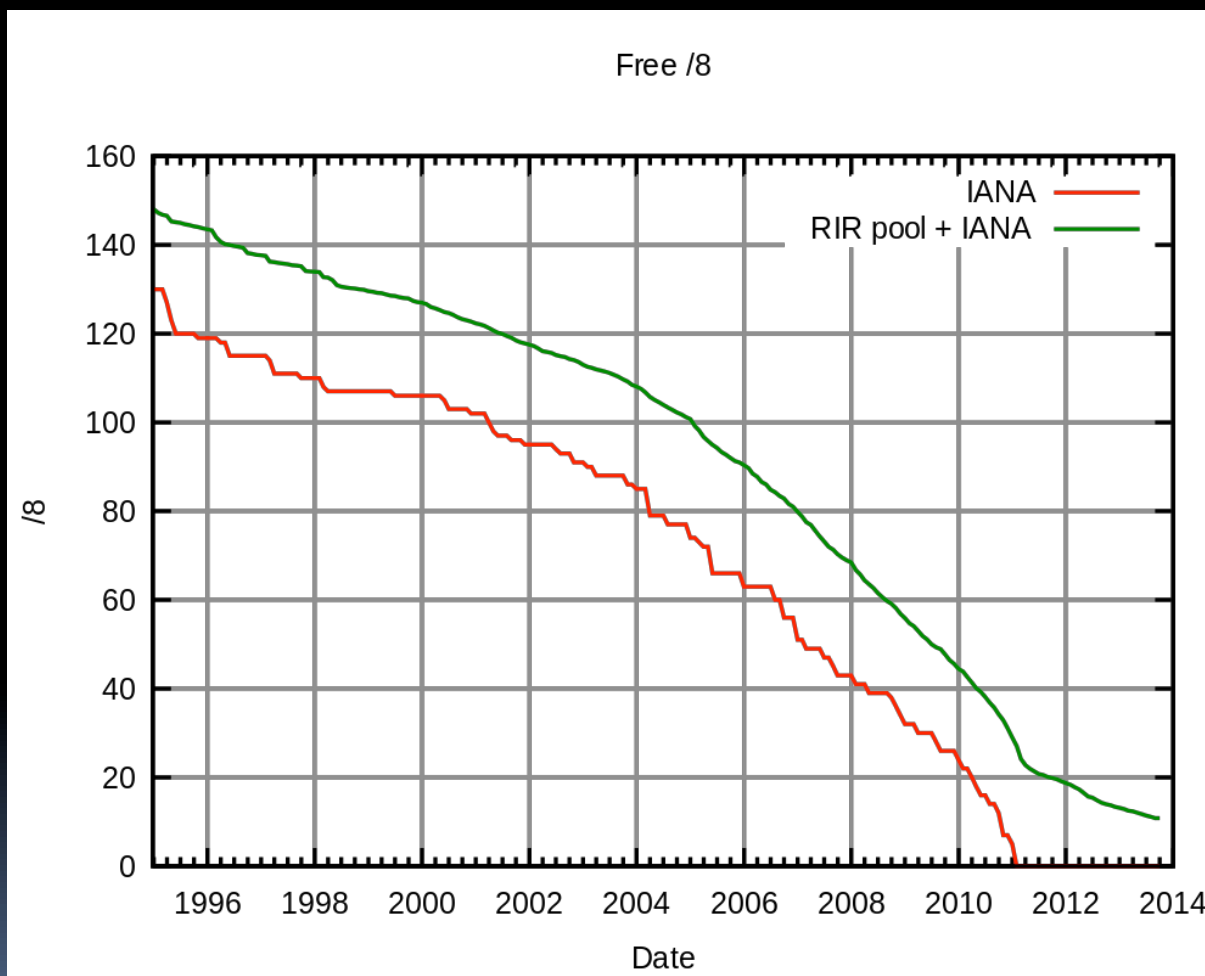
Take a moment and count: How many Internet-connected devices do you own?

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





Problem: No more IP addresses left...



Source: Wikimedia Commons





Solution: IPv6

An IPv6 address (in hexadecimal)

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



2001:0DB8:AC10:FE01::



1000000000000001:0000110110111000:1010110000010000:1111111000000001:

0000000000000000:0000000000000000:0000000000000000:0000000000000000

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





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

