UC Berkeley EECS
Lecturer
Gerald Friedland

The Beauty and Joy of Computing

Lecture #12
Internet I

Honeywell Lyric: Monitoring thermostats using the Internet.

http://www.youtube.com/watch?feature=player_embedded&v=WI-CgWLA5cY

Cool? (literally!)

But: Info sent to contractors so they can sell you products? So now they know when you are at home or not. Privacy?

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

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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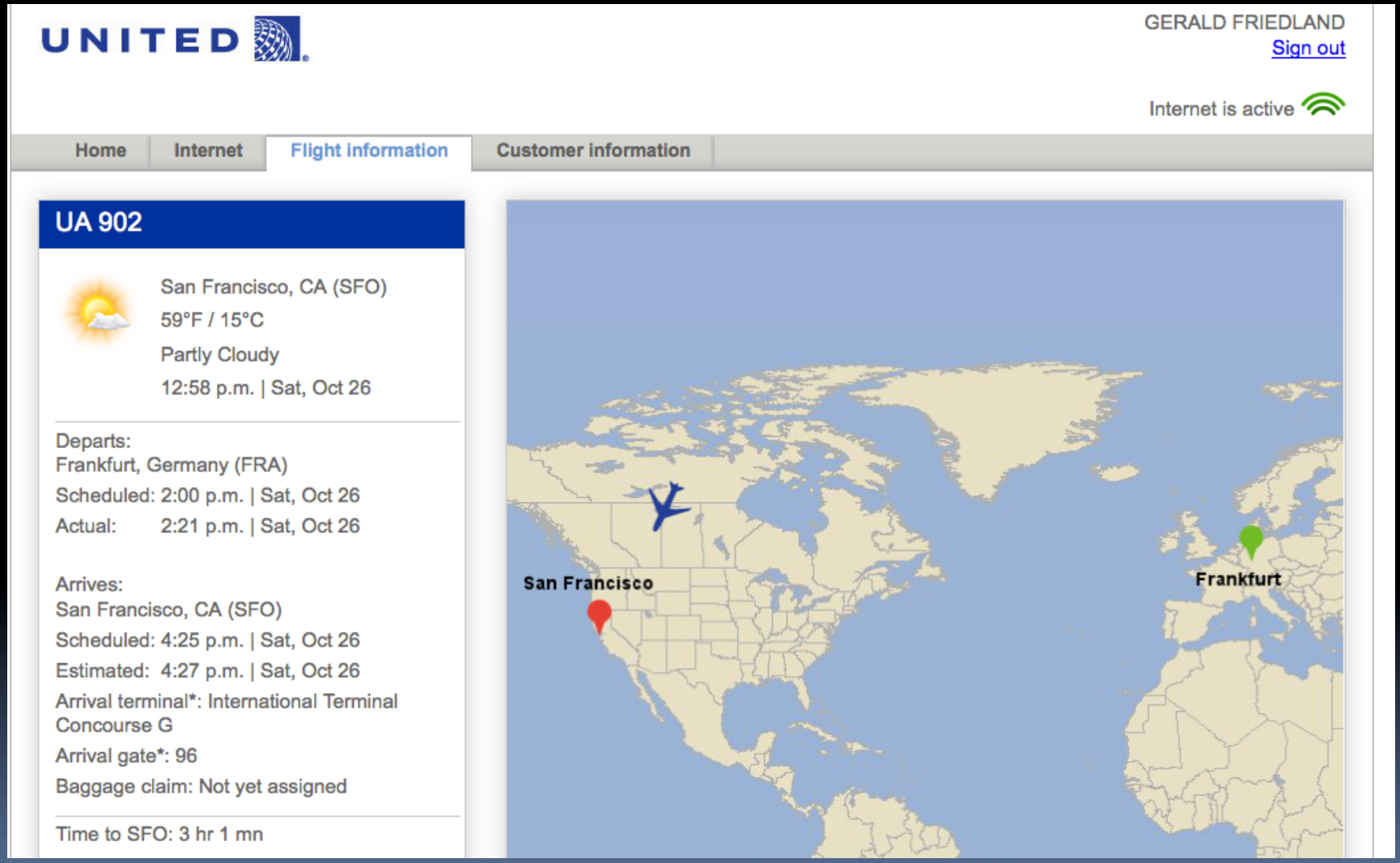
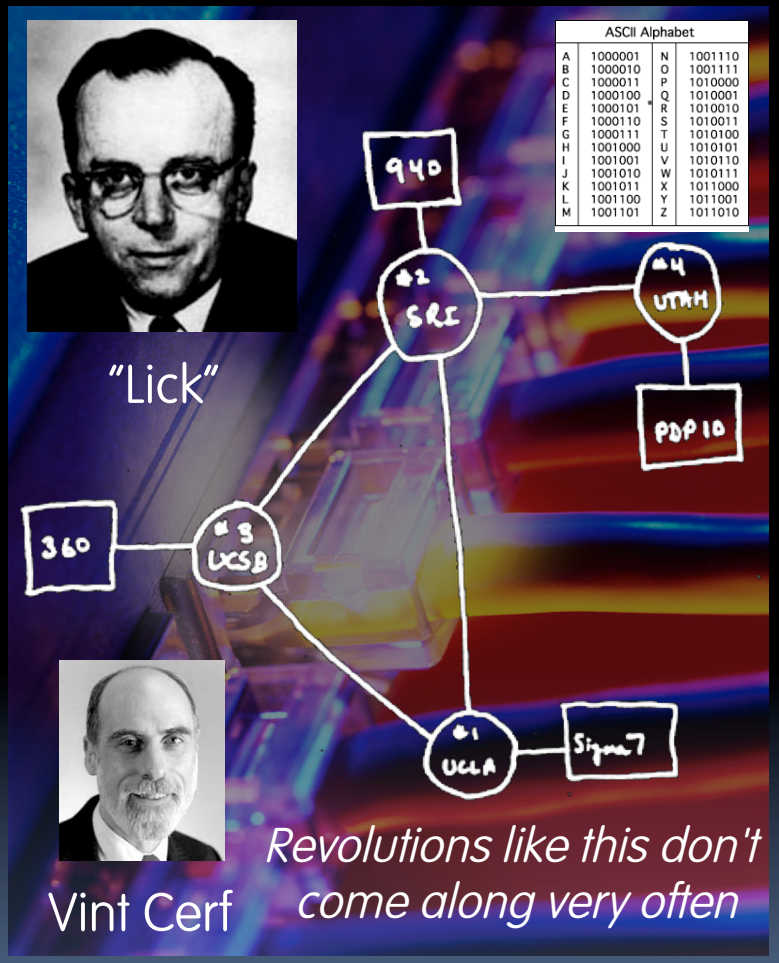
Internet is pretty much everywhere!



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!



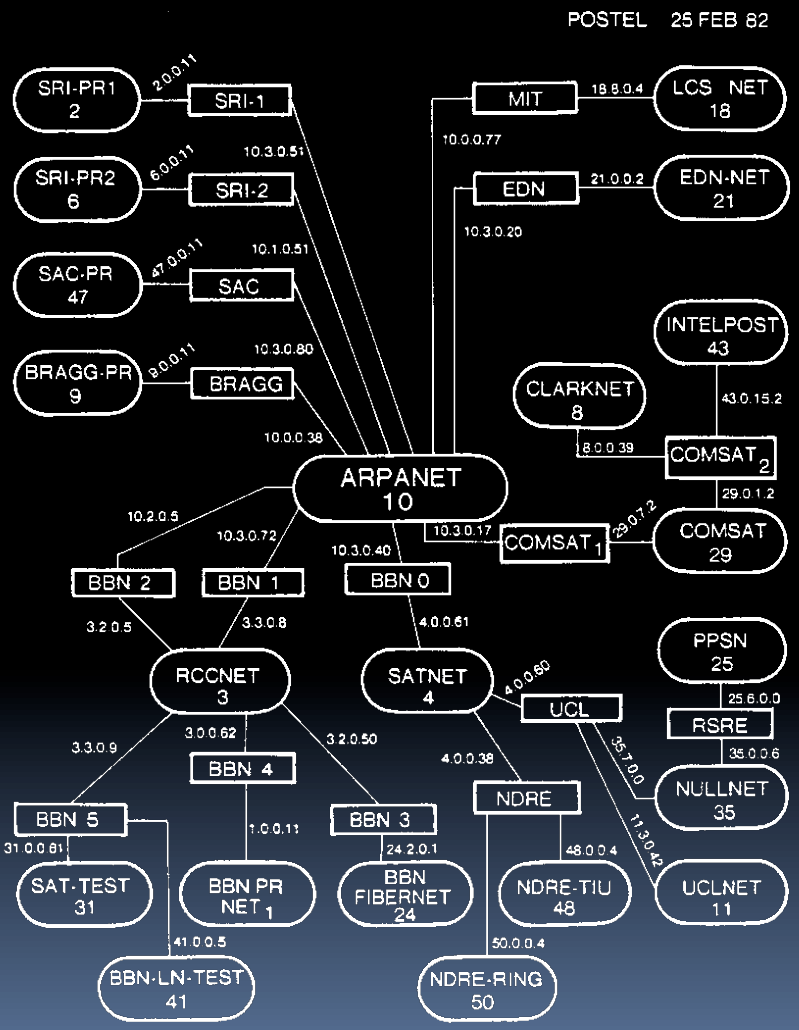
www.greatachievements.org/?id=3736

en.wikipedia.org/wiki/Internet_Protocol_Suite

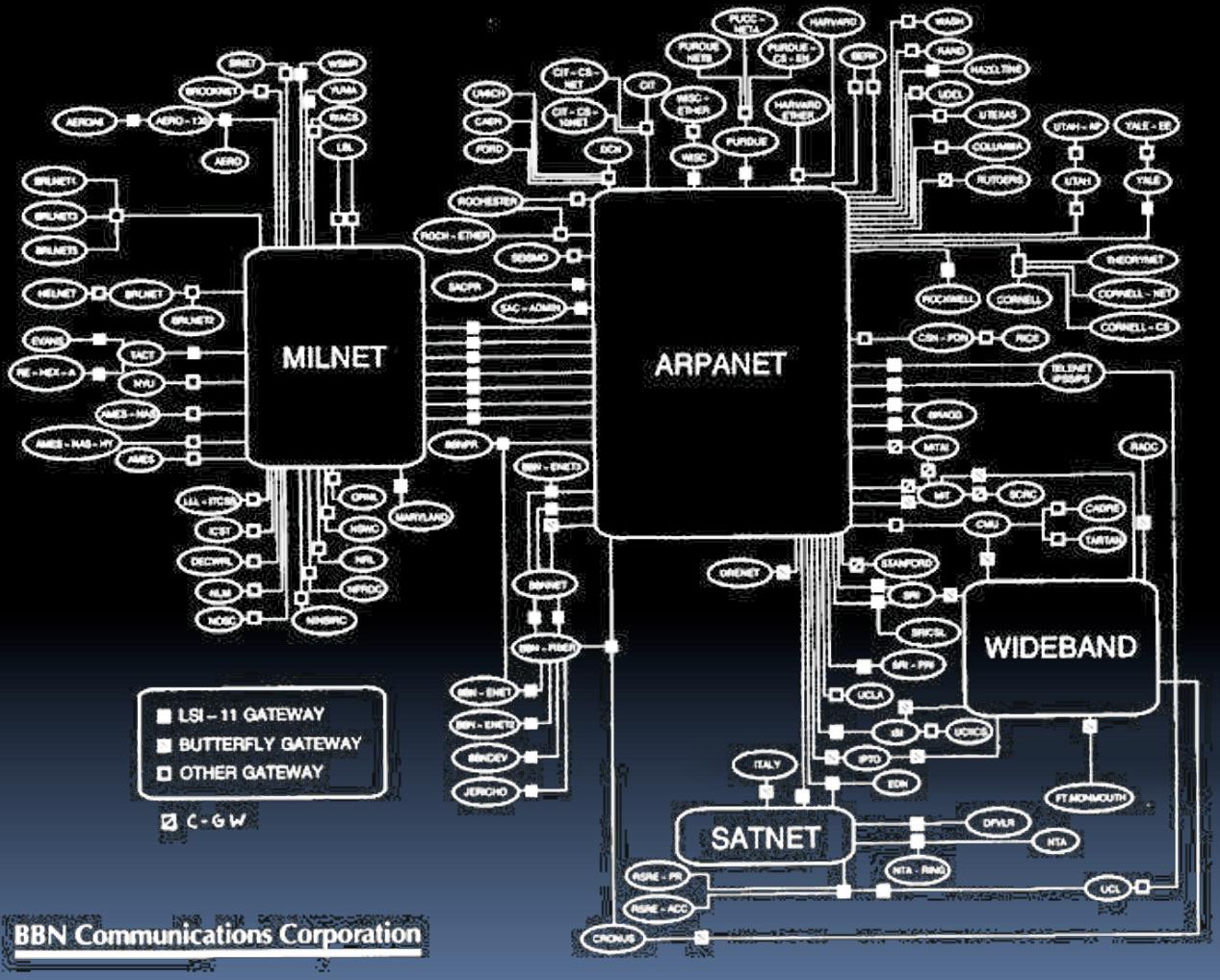
The basics of the basics

http://youtu.be/7_LPdttKXPc

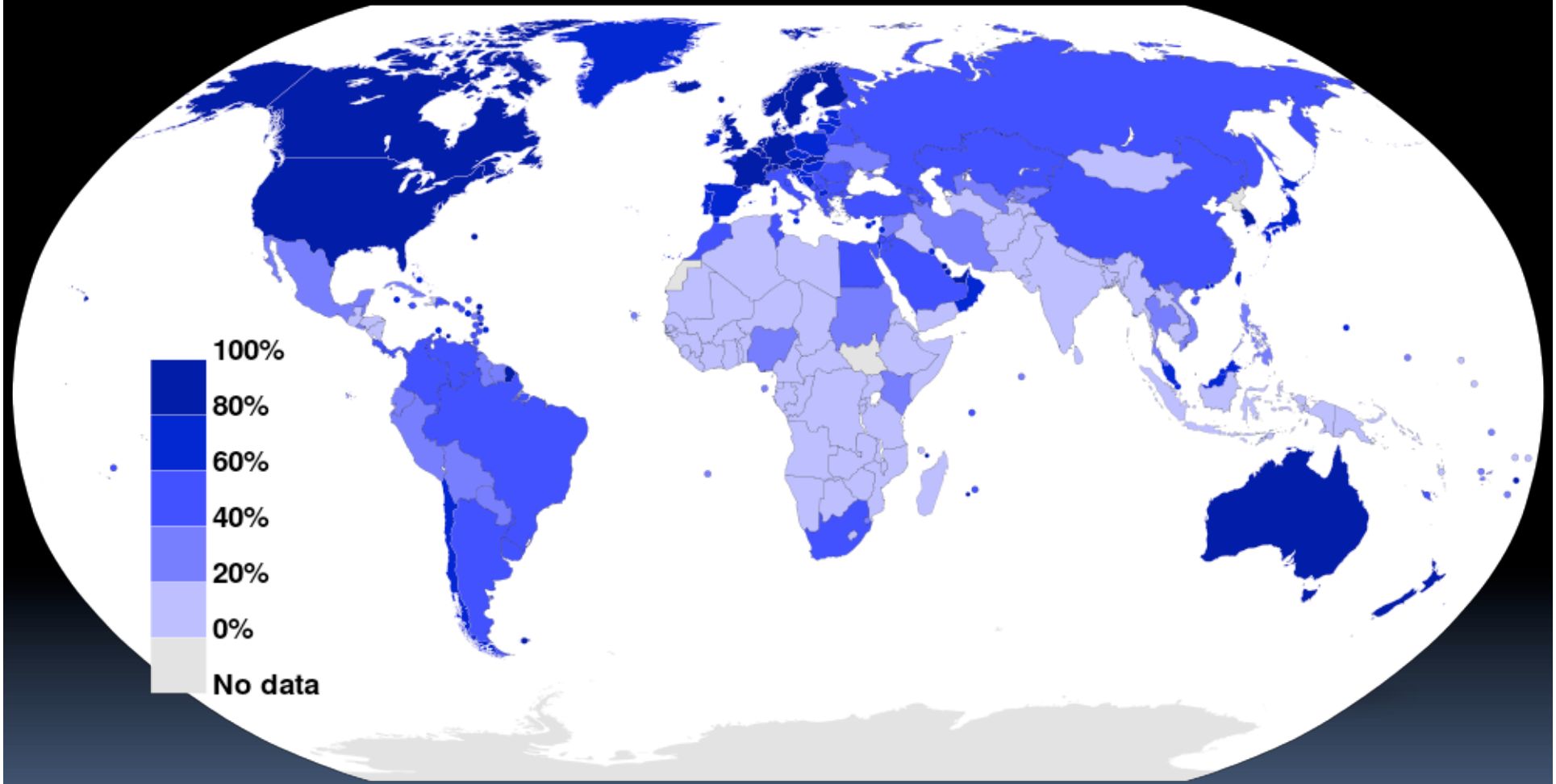
The Internet 1982



The Internet 1986



The Internet Today



Internet Usage as a Percentage of Population (2012)

Source: Wikimedia Commons

Question

Why is there only ONE Internet?

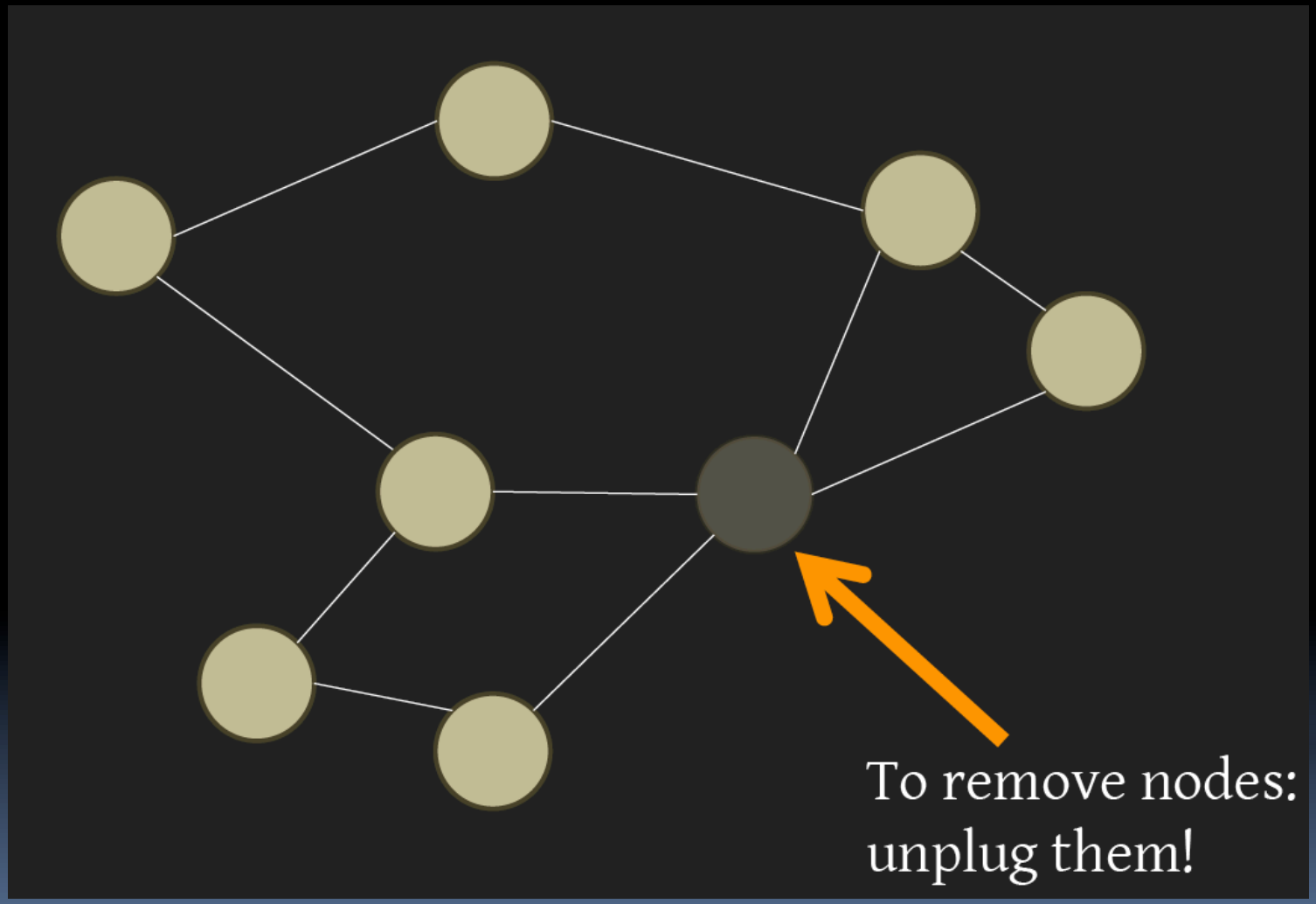
Picture credit: Chelsea Ganske

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



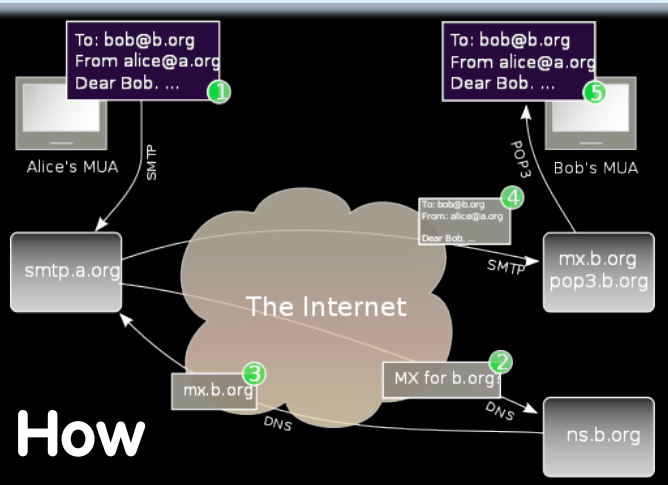
Source: BJC Spring 12, Lecture 17

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

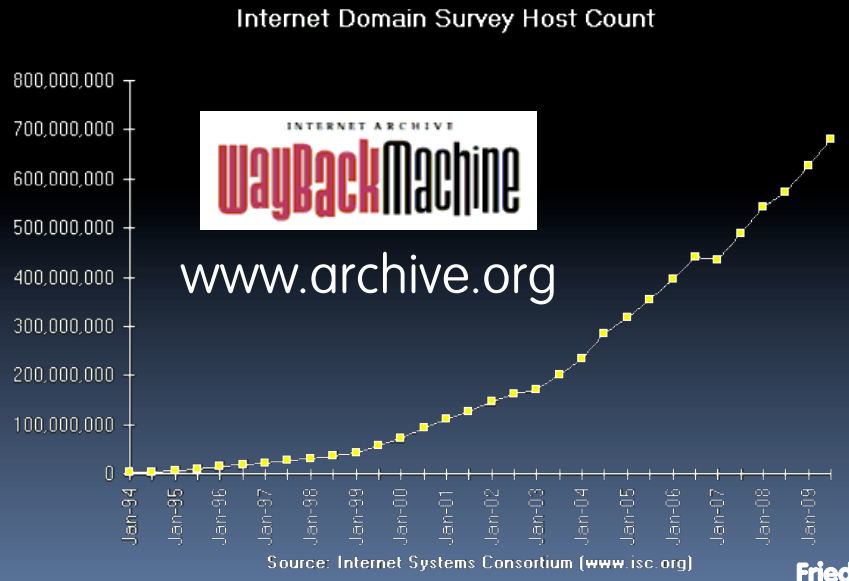
en.wikipedia.org/wiki/History_of_the_World_Wide_Web

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 ARCHIVE WayBackMachine

www.archive.org

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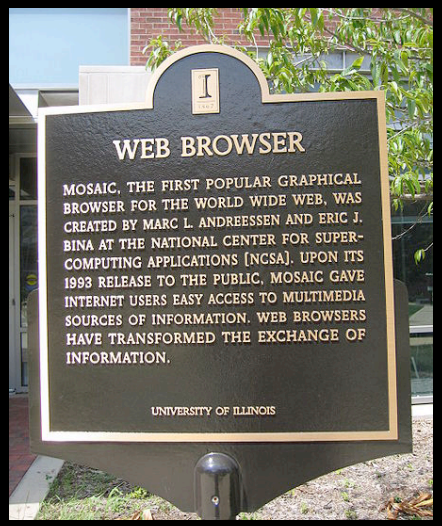
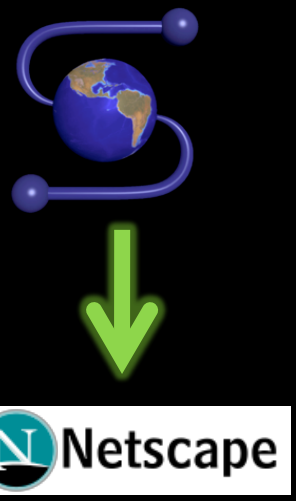
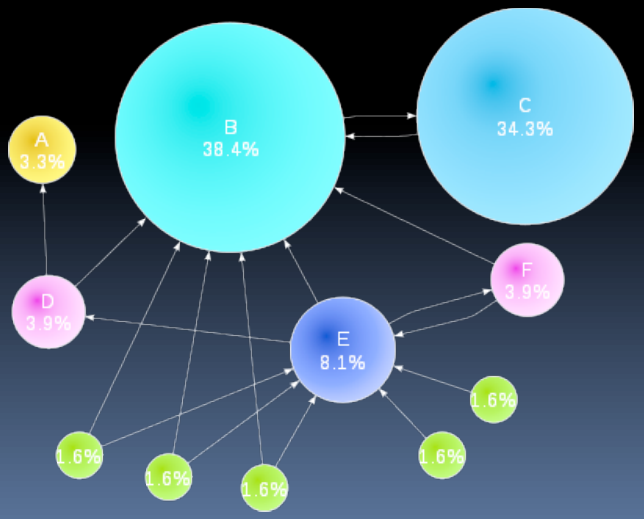
WWW Search & Browser (1993)

- **Browser**
  - Marc L. Andreesen 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)





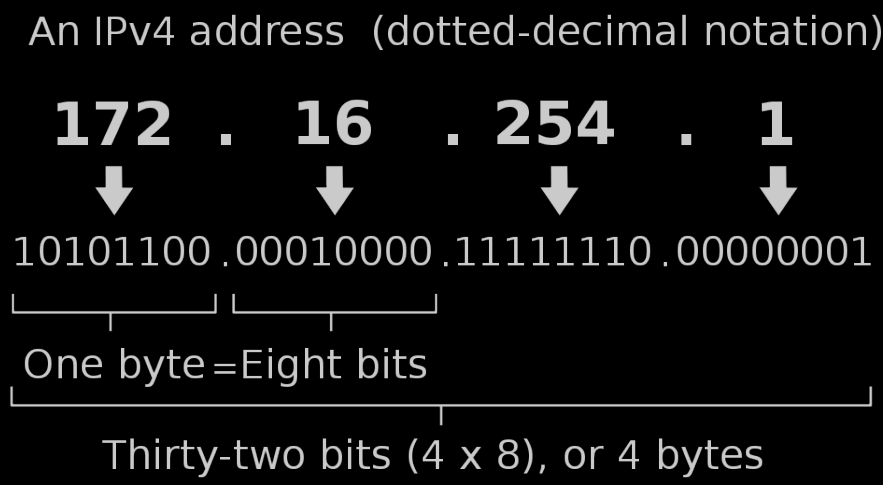


Web 2.0 : The Social Network (2004)

- **"…web development & design that facilitates interactive information sharing, interoperability, user-centered design and collaboration on WWW"**
  - Users change content via "architecture of partipation"
- **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



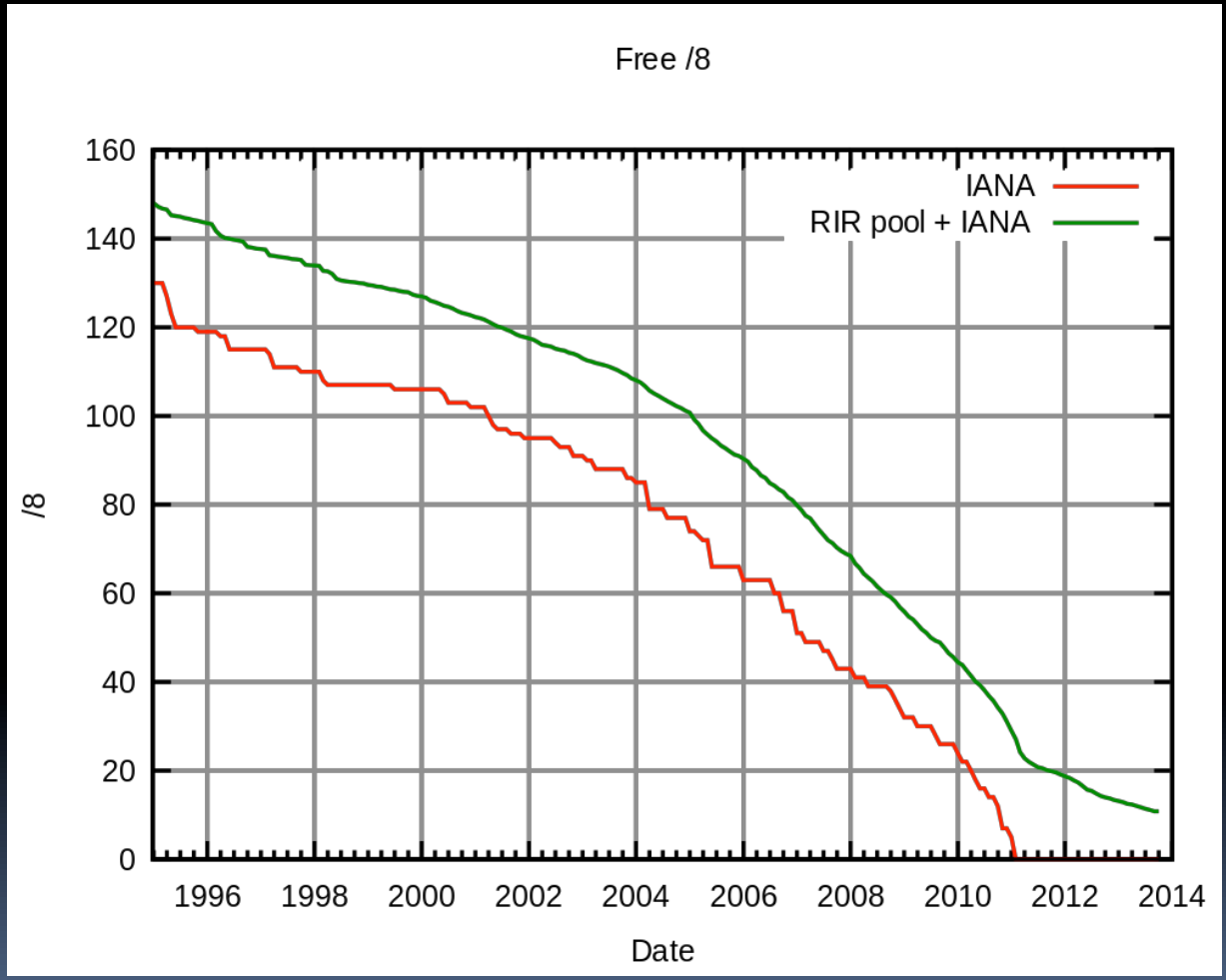
- Split: First part network, second part computer indicated by /bits: e.g. 192.168.1.103/16
- 2^{32} = 4 billion unique numbers (world population 7 billion)

Count

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

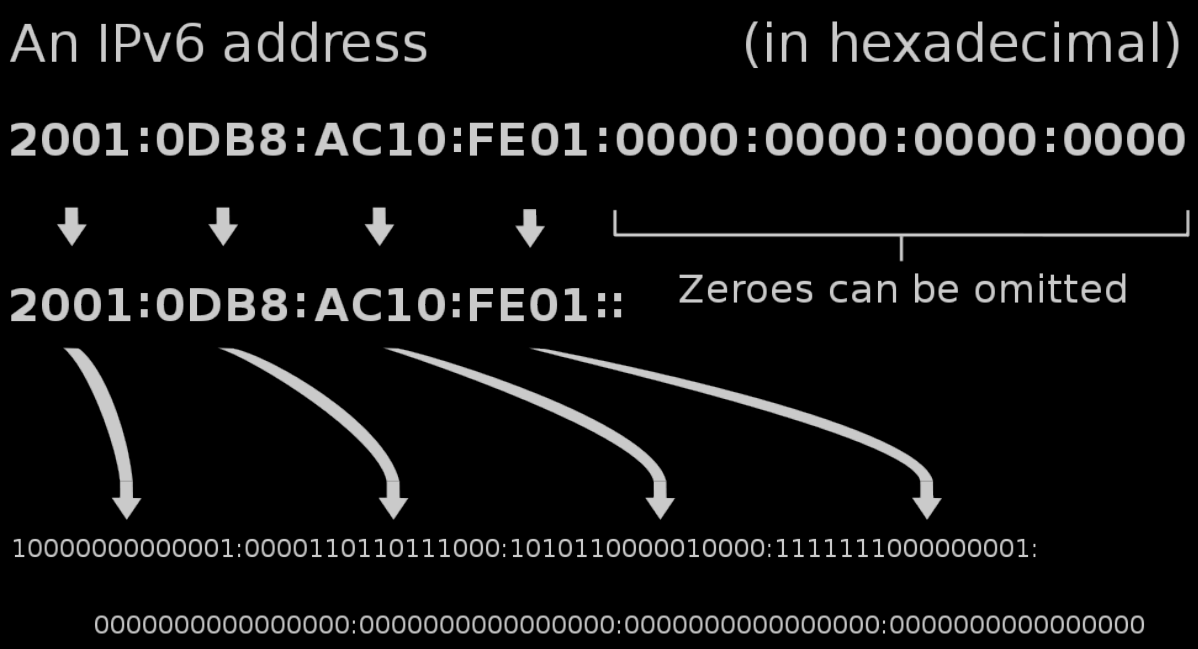
a) 0
b) 1
c) 2-5
d) 5-10
e) More than 10

Problem: No more IP addresses left…



Source: Wikimedia Commons

Solution: IPv6



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

Summary and Outlook

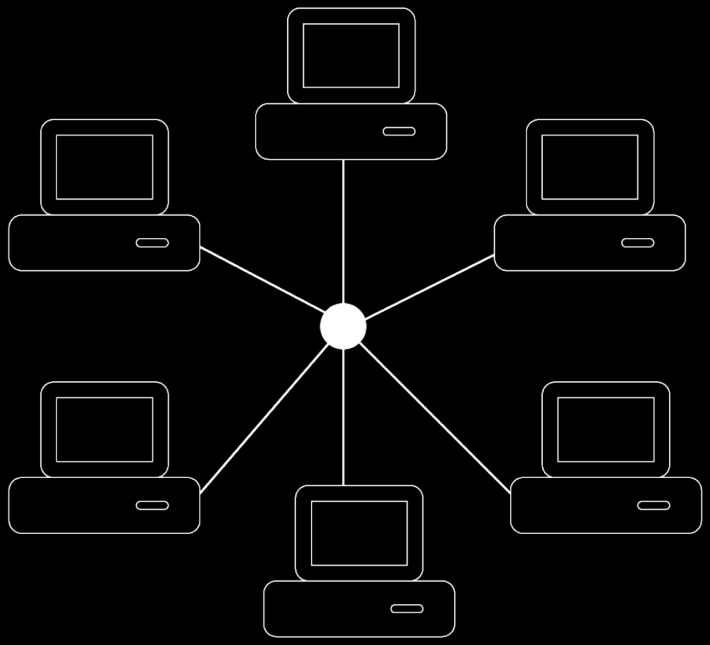
- The Internet is setup for growth using **open standards**
- It is highly failure tolerant due to **decentralization**
- However, issues arise with trying to improve it.

Internet II (later):

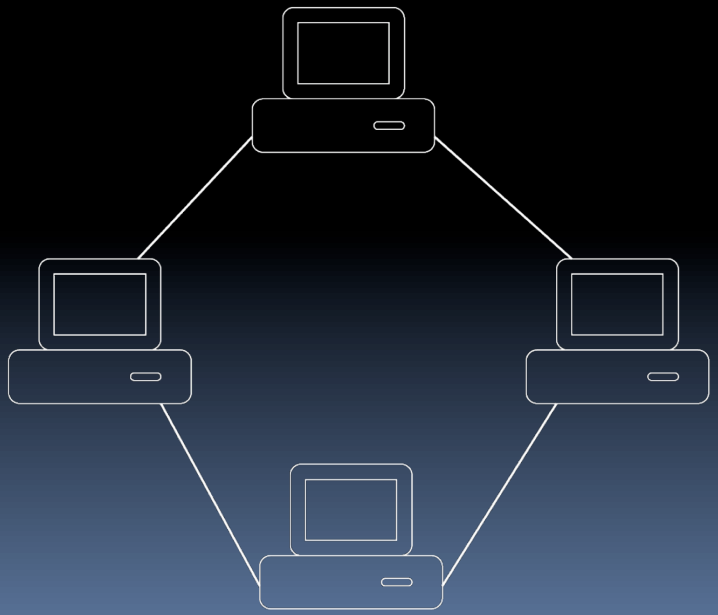
- Routers
- Internet Protocols
- Vulnerabilities of the Internet
- More on Social Implications

Network Topologies

Point-to-Point (Peer-to-Peer)

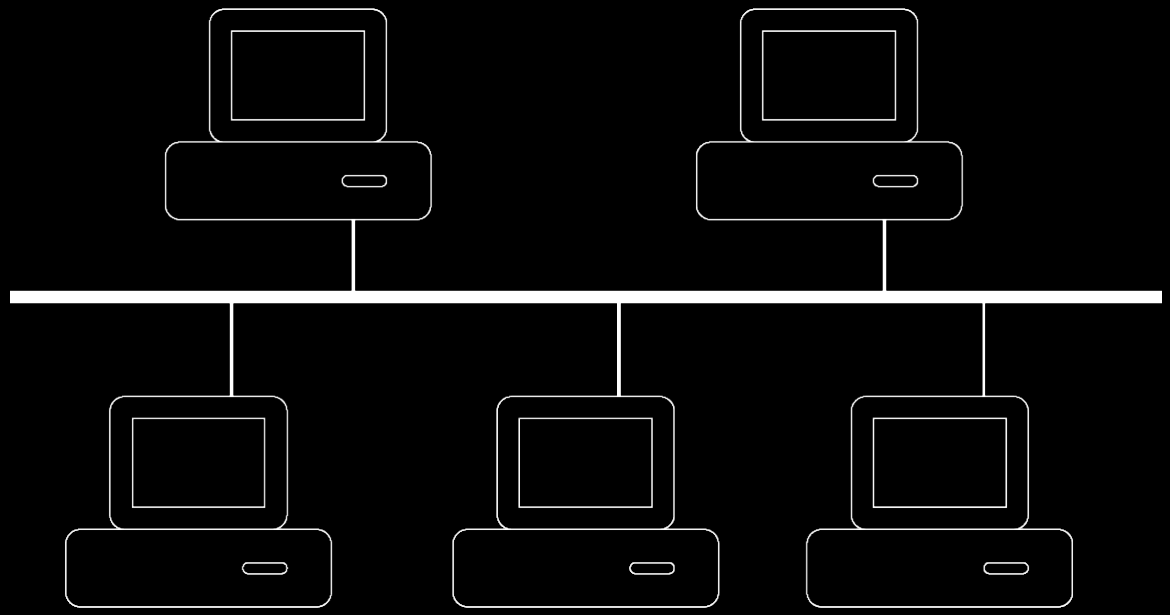


Starnet/Arcnet



Token Ring

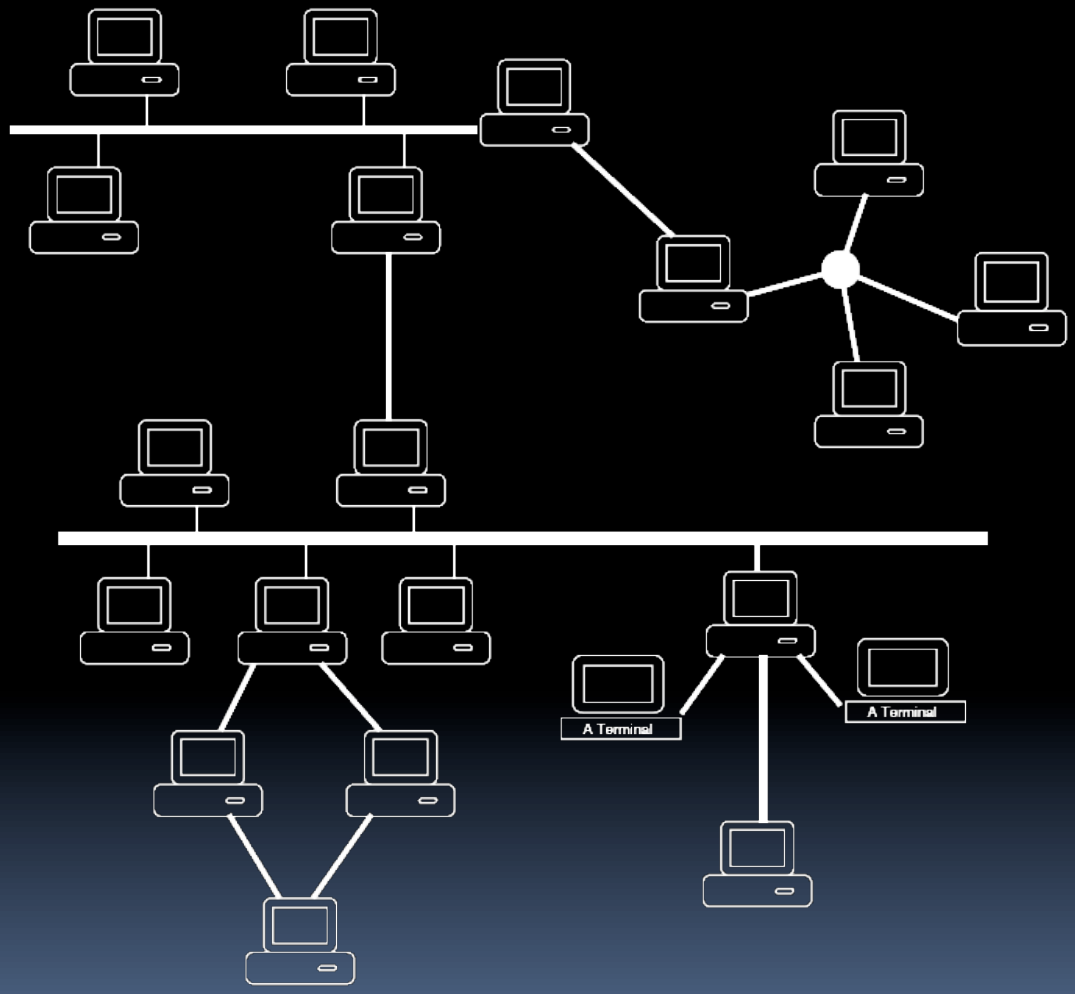
Network Topologies II



Ethernet (Bus)

- Most prevalent network today
- Wireless networks = Ethernet topology!

Network Topologies III



An internet

IP Address Allocation

IANA (Internet Assigned Numbers Authority) allocates network addresses to entities by delegating to RIRs (Regional Internet Registries).

IANA-reserved private IPv4 network ranges

	Start	End	No. of addresses
24-bit block (/8 prefix, 1 × A)	10.0.0.0	10.255.255.255	16 777 216
20-bit block (/12 prefix, 16 × B)	172.16.0.0	172.31.255.255	1 048 576
16-bit block (/16 prefix, 256 × C)	192.168.0.0	192.168.255.255	65 536

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Domain Name Service

DNS is used to resolve names to IP addresses in a decentralized manner