Internet History

Charles Severance

https://www.coursera.org/course/insidetheinternet

Coursera

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- Thanks to IEEE Computer for permisison to use IEEE Computer magazine articles associated with the videos
- Thanks to Richard Wiggins for the use of his video material
- Thanks to Dave Malicke and Open Michigan (open.umich.edu) for help with copyright review of these materials

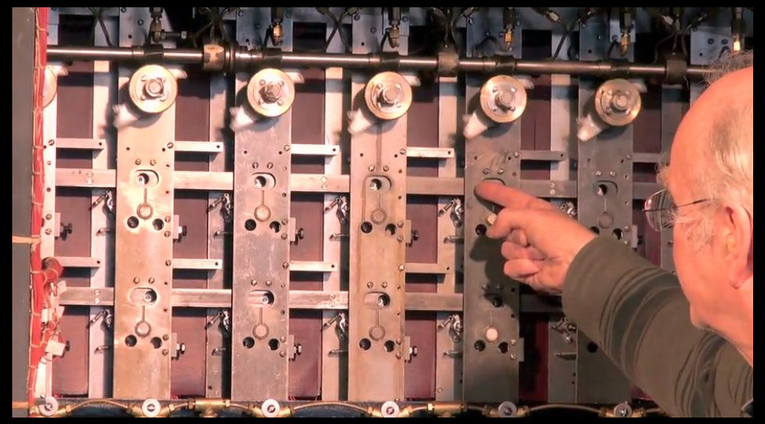
High Level Phases

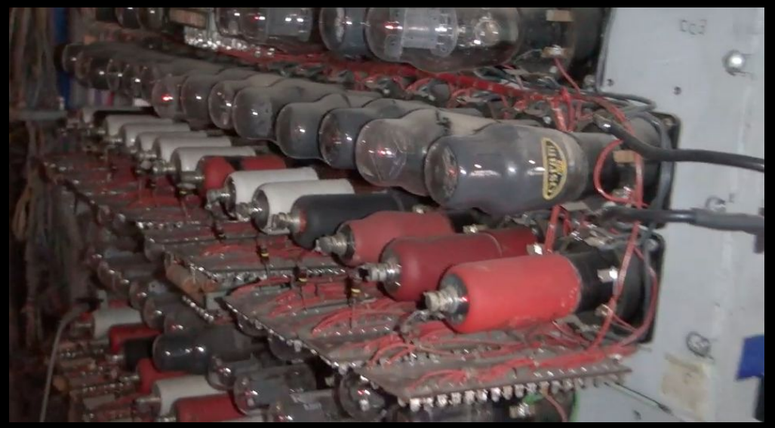
- Dawn of Electronic Computing
- Pre-Internet Communication
- Research Networks - 1960s - 1970's
- The First "Internet" - Mid 1980's
- The Web Makes it Easy - Early 1990's
- Ubiquity of the Internet - 1996 and beyond

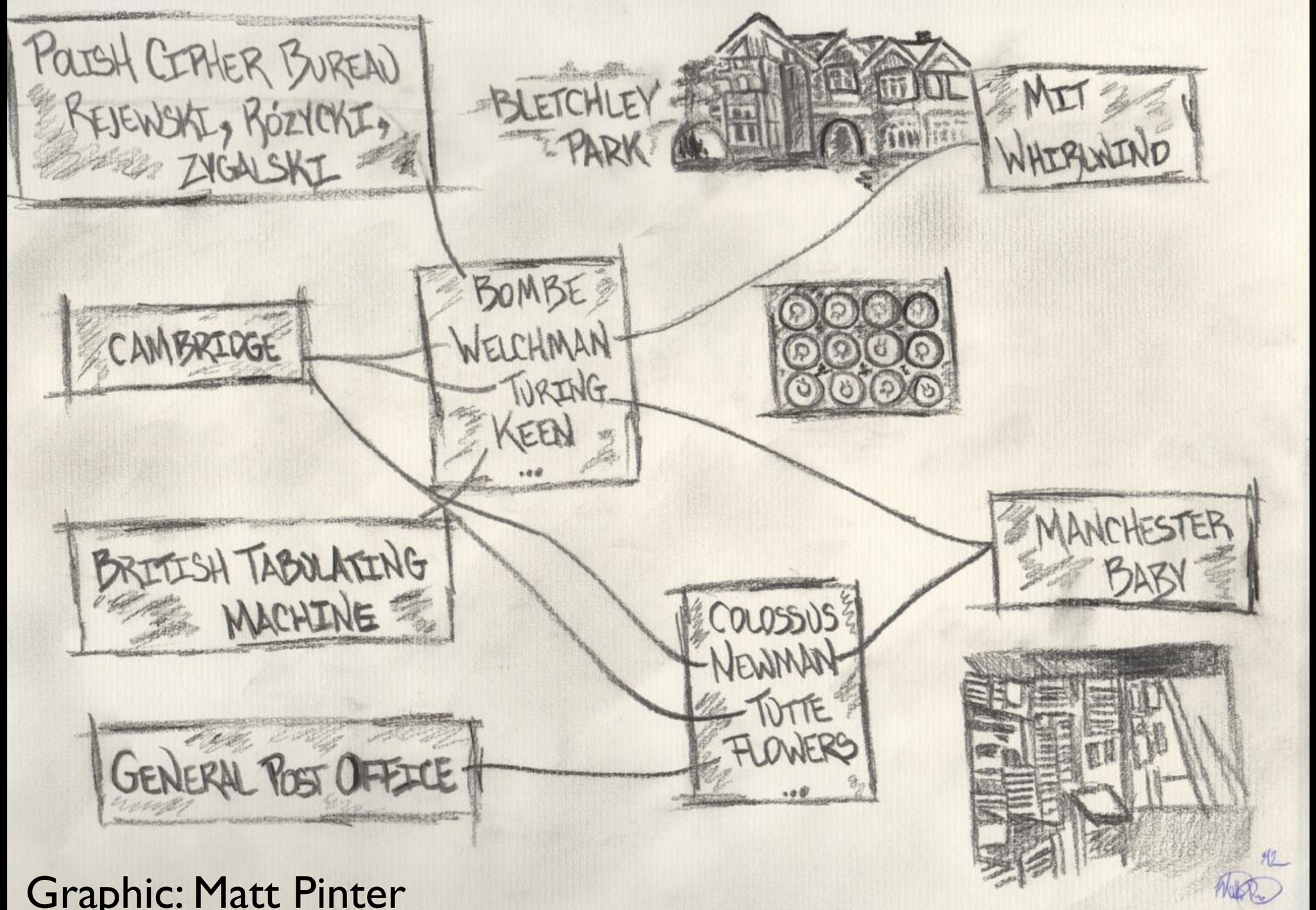
Alan Turing and Bletchley Park

- Top secret code breaking effort
- 10,000 people at the peak (team effort)
- BOMBE: Mechanical Computer
- Colossus: Electronic Computer

http://www.youtube.com/watch?v=5nK_ft0Lf1s





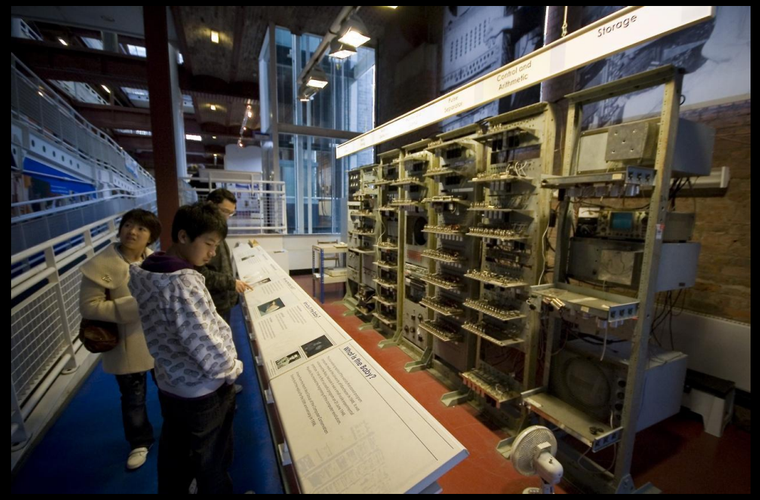


Graphic: Matt Pinter

24:50

Post-War (1940s)

- Alumni of the US and UK codebreaking efforts and other started building general purpose computers
  - Manchester Baby
  - Ferranti Mark I
  - Harvard Mark I
  - US Army ENIAC



http://upload.wikimedia.org/wikipedia/commons/b/bb/SSEM_Manchester_museum.jpg
http://en.wikipedia.org/wiki/File:Classic_shot_of_the_ENIAC.jpg

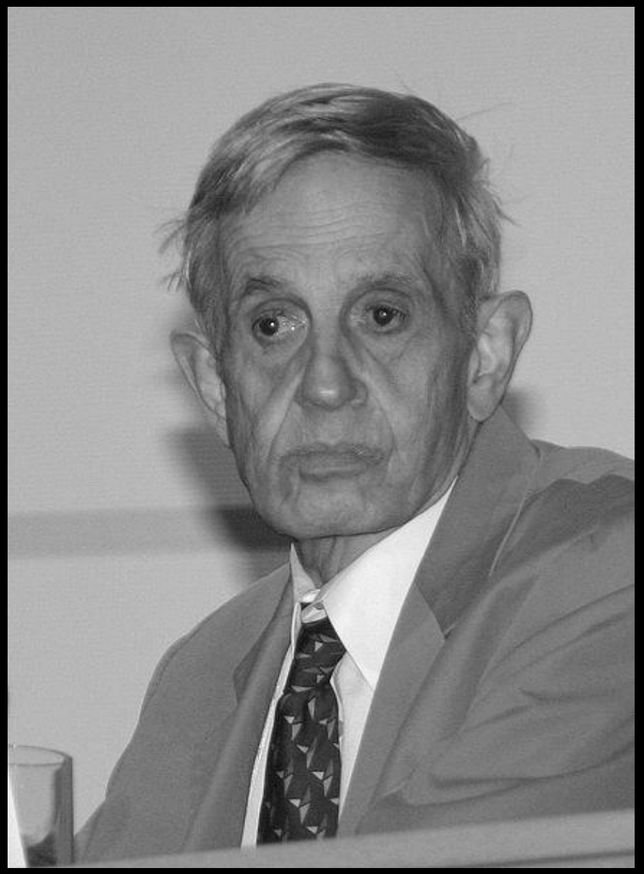
Post-War (1950s)

- Math / Science “Won the war”
- Broad-based investment in maintaining the US/West intellectual lead
- Mathemeticians were valued, recruited, brilliant, arrogant, and quirky
- "A Beautiful Mind" gives a sense of the culture of the time

http://www.youtube.com/watch?v=CemLiSI5ox8

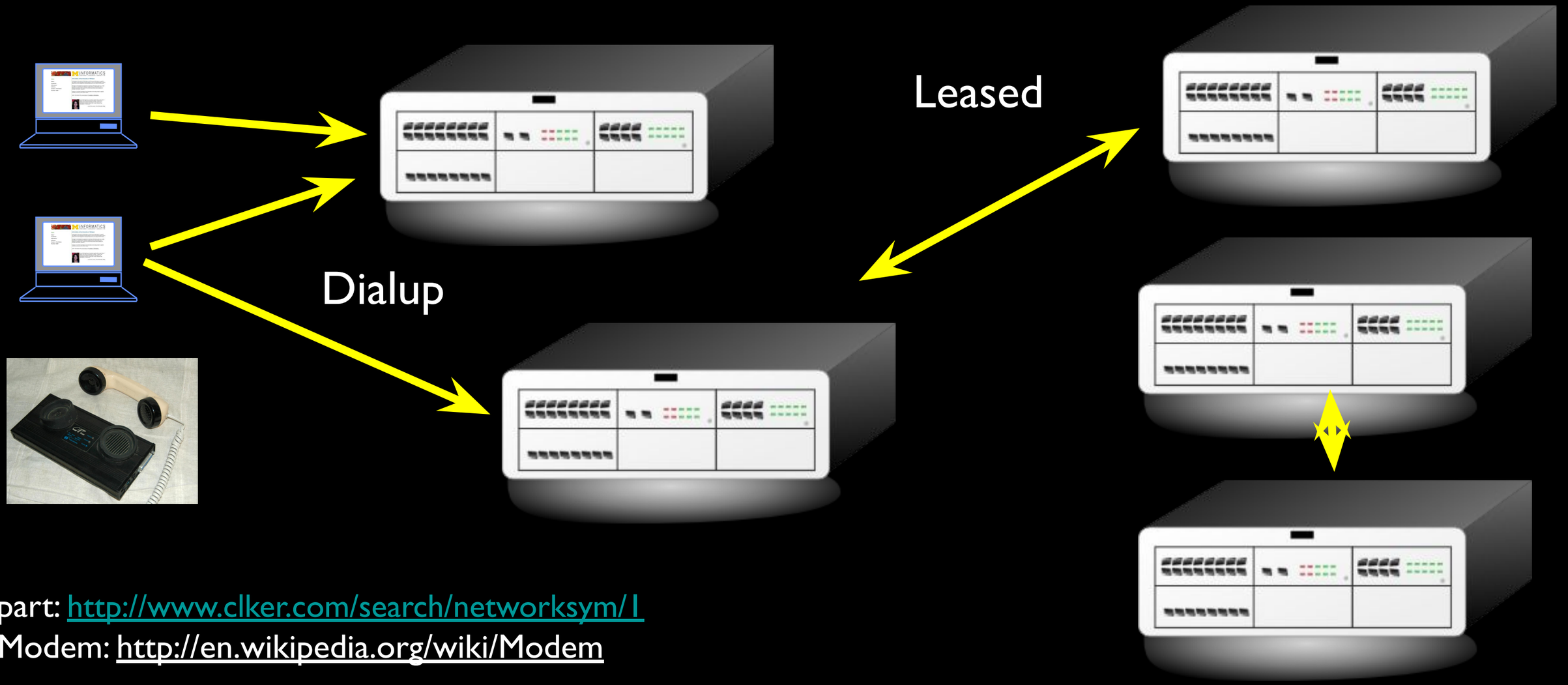
John Forbes Nash

- Received his Phd. Mathematics at Princeton in 1950 at 22 years old
- Mathematics faculty at MIT - 1951 - 1958
- Schizophrenia 1959 - 1995
- Nobel Prize in Economic Sciences - 1994



http://en.wikipedia.org/wiki/John_Forbes_Nash

Phone Line Networking



Clipart: http://www.clker.com/search/networksym/1

Modem: http://en.wikipedia.org/wiki/Modem

Dial-Up Access

- You were happy to connect to one computer without having to walk across campus
- You could 'call' other computers long distance
- The characters were encoded as sound
- Pretty Common in the 1970's

http://deepblue.lib.umich.edu/handle/2027.42/79576 (1969)

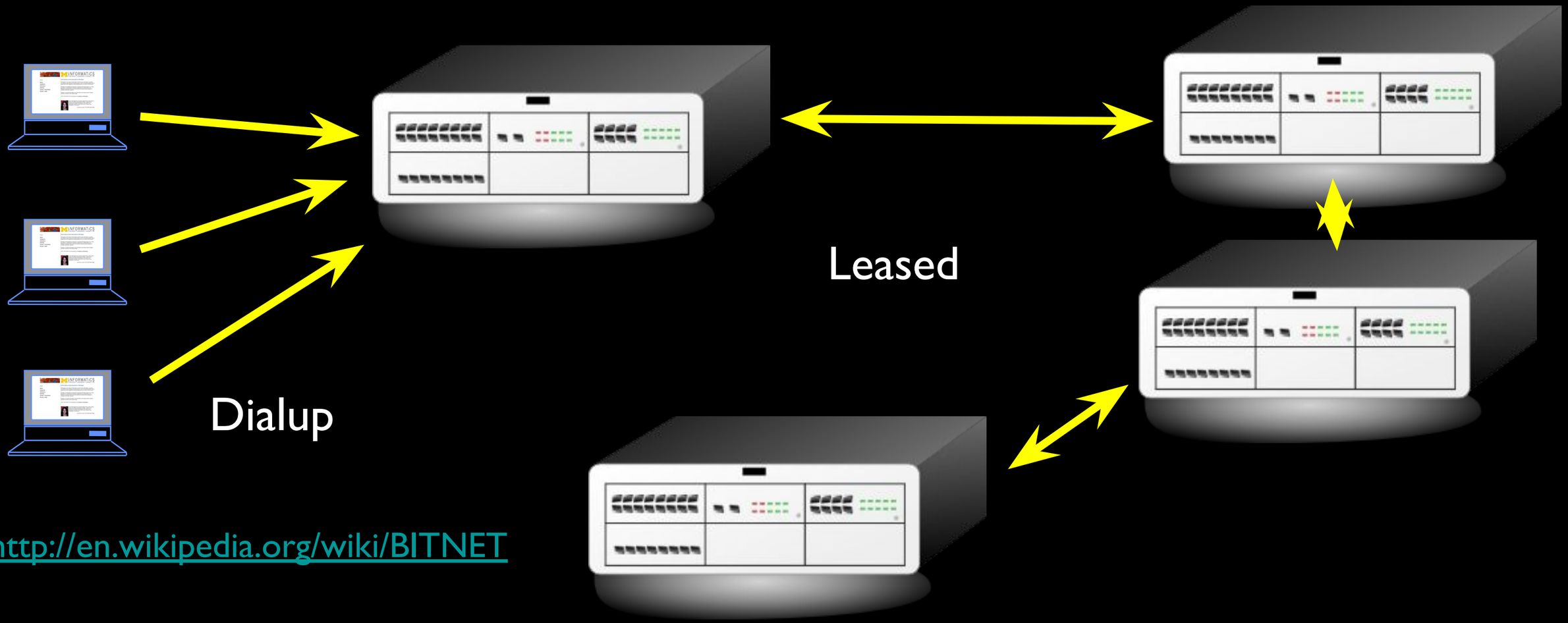
6:00

Data Transfer with Leased Lines

- You could get a dedicated connection between two points from the phone company
- No dialing was needed leased lines are always connected
- Reserved dedicated phone wires and permanent connections
- Expensive because of limited copper - cost was based on distance
- Think bank branch offices and other places where cost is significant

http://en.wikipedia.org/wiki/Leased_line

Store and Forward Networking



http://en.wikipedia.org/wiki/BITNET

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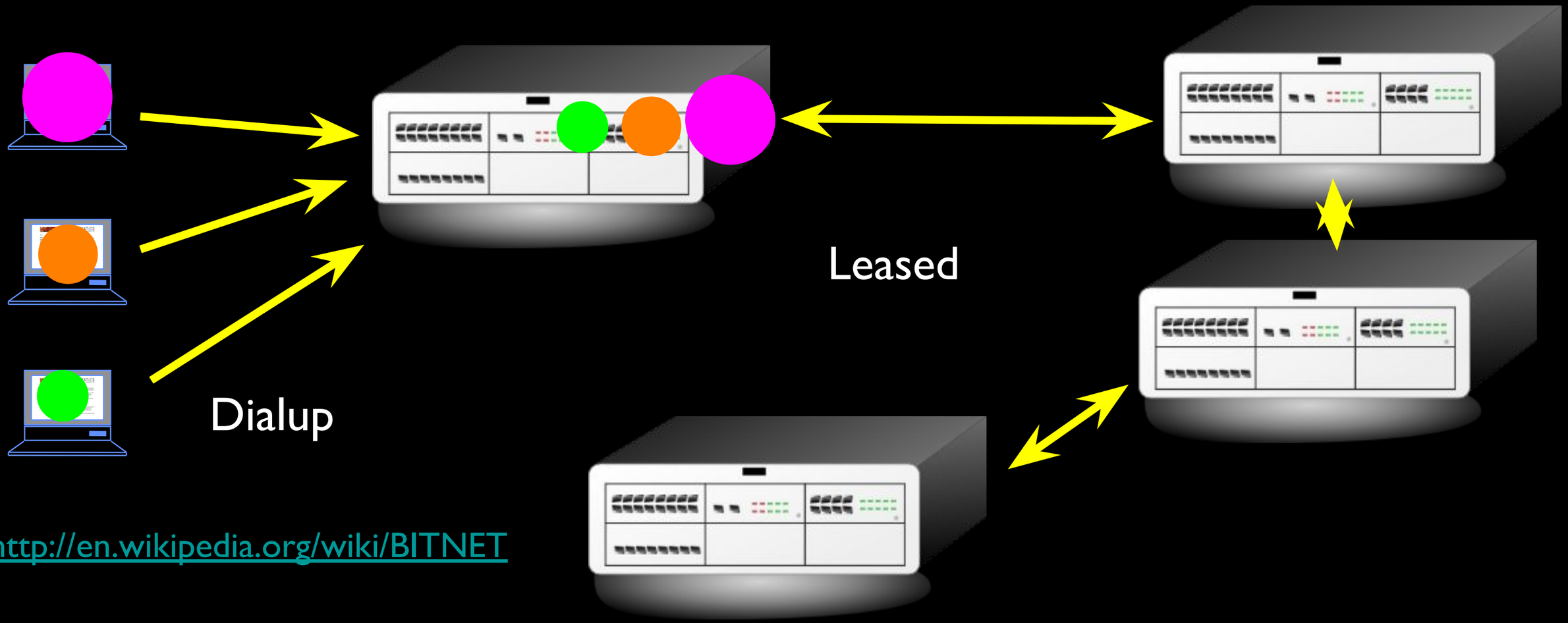
Store and Forward Networking



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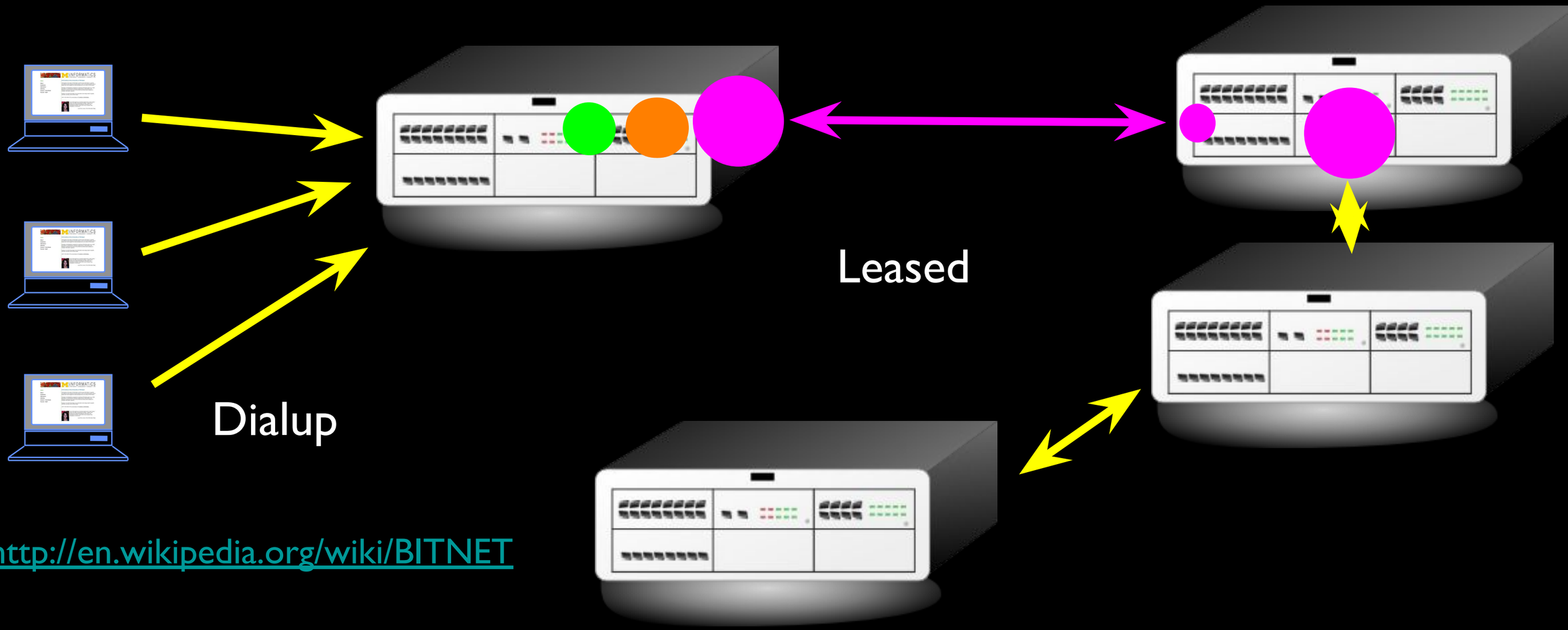

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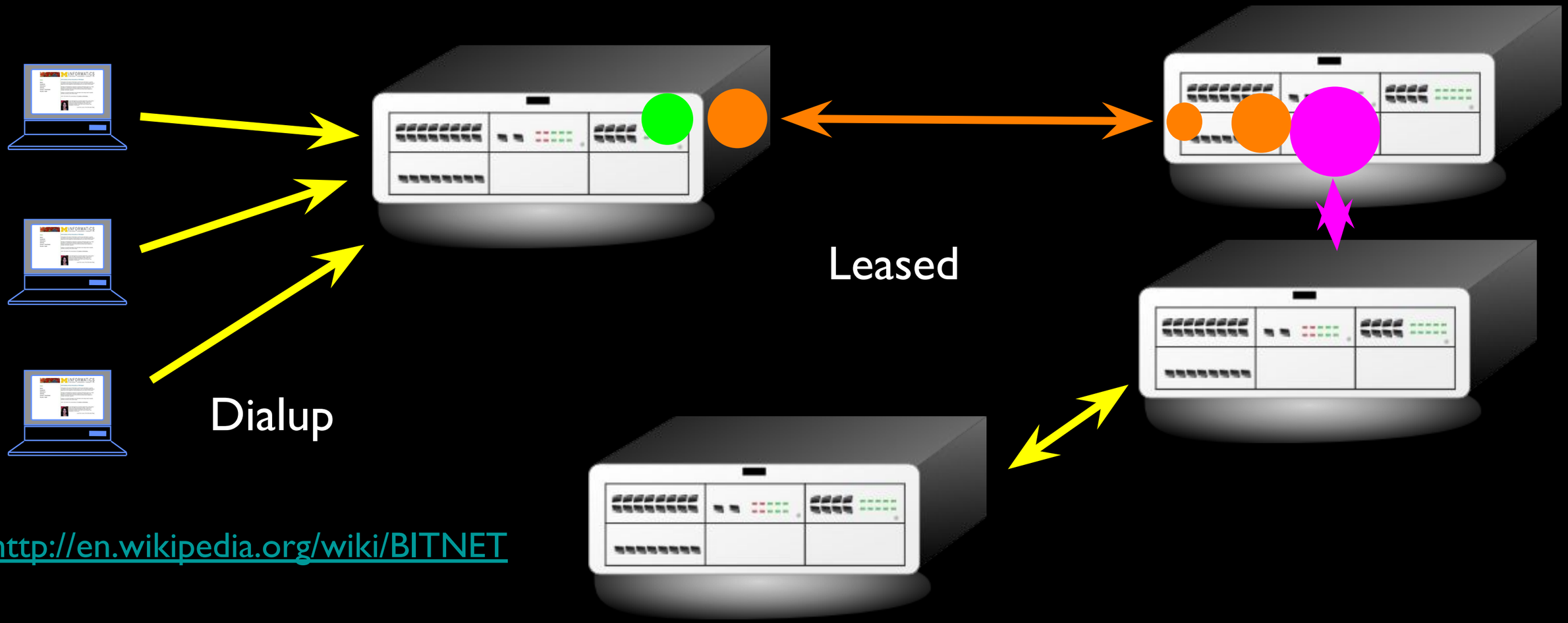

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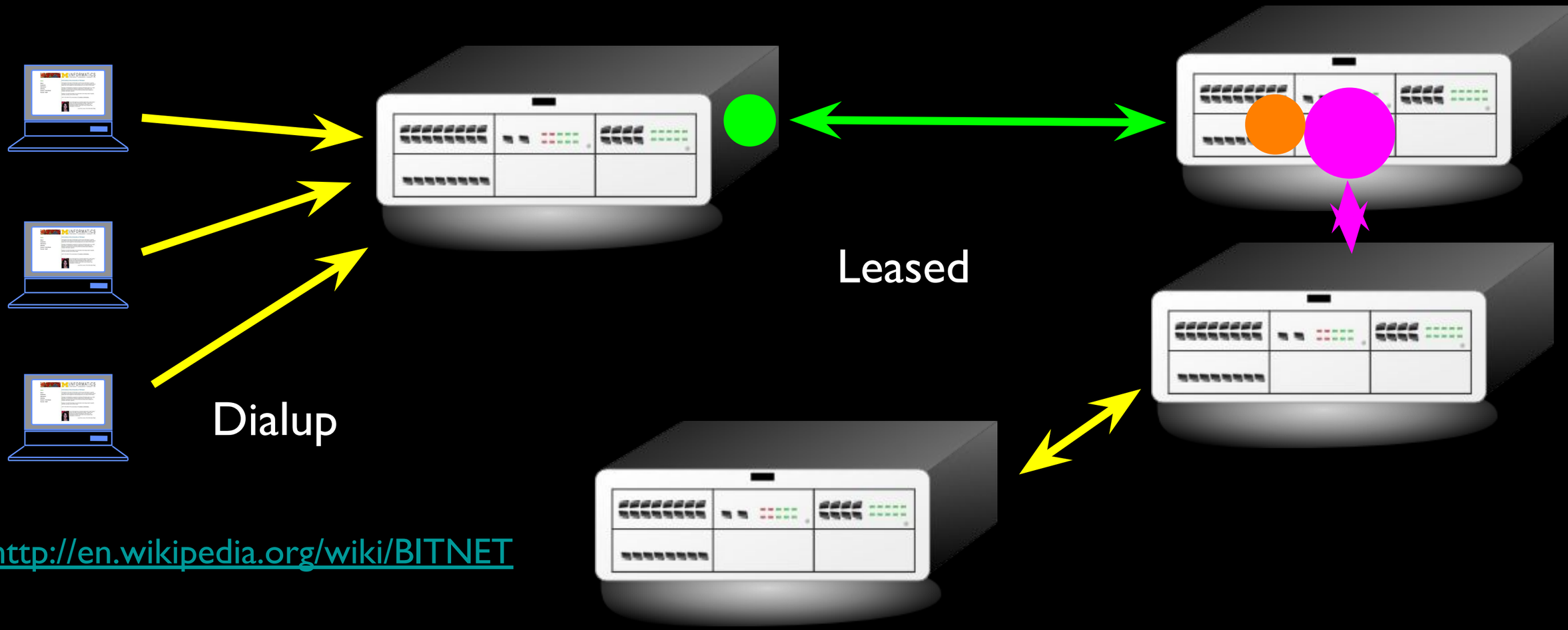
Store and Forward Networking



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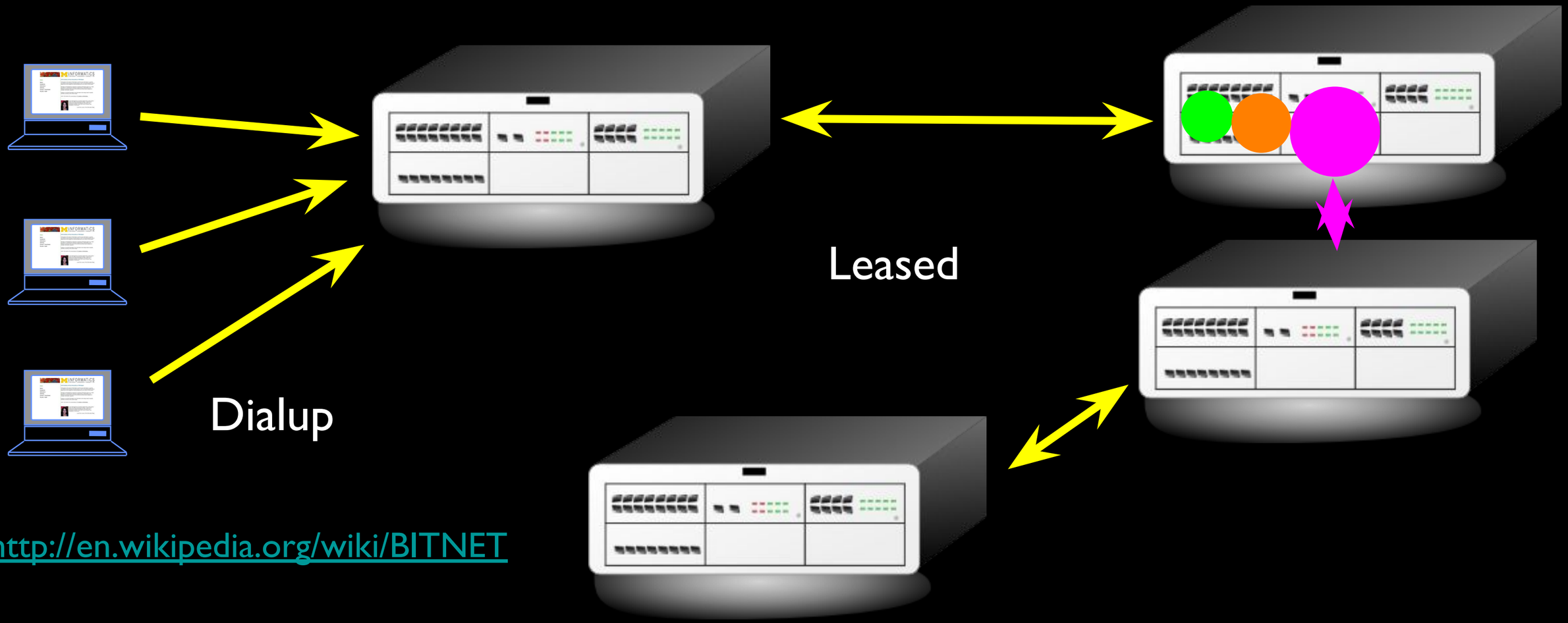


http://en.wikipedia.org/wiki/BITNET

Clipart: http://www.clker.com/search/networksym/1


Saving Money with
More "Hops"
Lansing
Ann Arbor
Detroit
Toledo
Cleveland
Grand Ledge
Mason
Howell
Brighton
Waterford Charter Township
Rochester Hills
Troy
Sterling Heights
West Bloomfield Charter Township
Farmington Hills
Southfield
Warren
Harrison Charter Township
Marine City
St Clair
Dawn-Euphemia
Wallaceburg
West Elgin
Dutton/ Dunwich
Waterloo State Recreation Area
Albion
Jackson
Tecumseh
Hillsdale
Osseo
Adrian
Monroe
LaSalle
Trenton
Riverview
Boston
Leamington
Lake Erie
Sylvania
Perrysburg
Montpelier
Archbold
Bryan
Napoleon
Bowling Green
Fremont
Vickery
Huron
Sandusky
Port Clinton
Oak Harbor
Vermilion
Lorain
Avon
Avon Lake
Amherst
Elyria
Parma
Euclid
Willowick
Shaker Heights
Solon

Store and Forward Networking

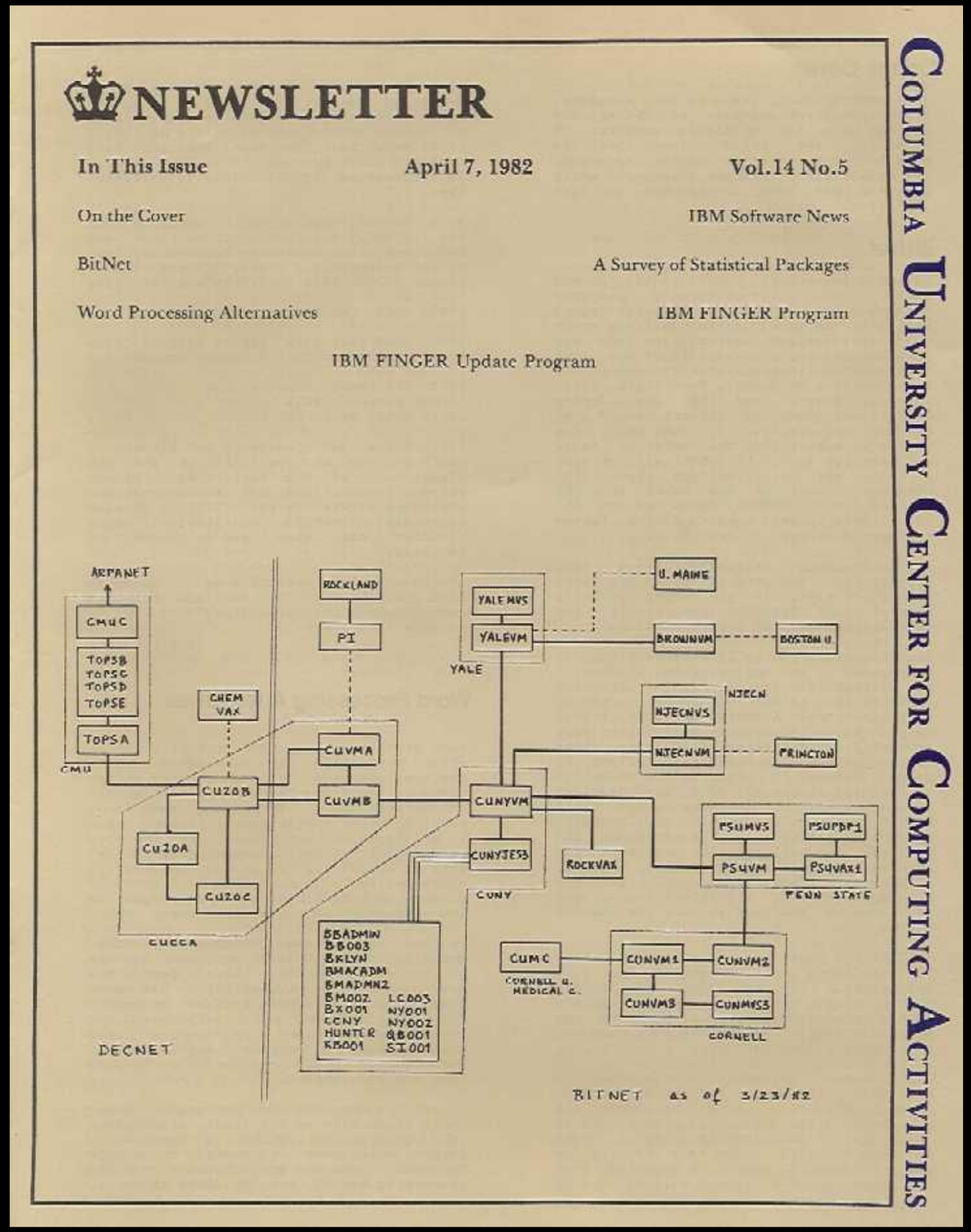
- Typically specialized in Mail
- E-Mail could make it across the country in six hours to about 2 days
- You generally focused your life on one computer
- Early 1980's

http://en.wikipedia.org/wiki/IBM_3270

BITNET

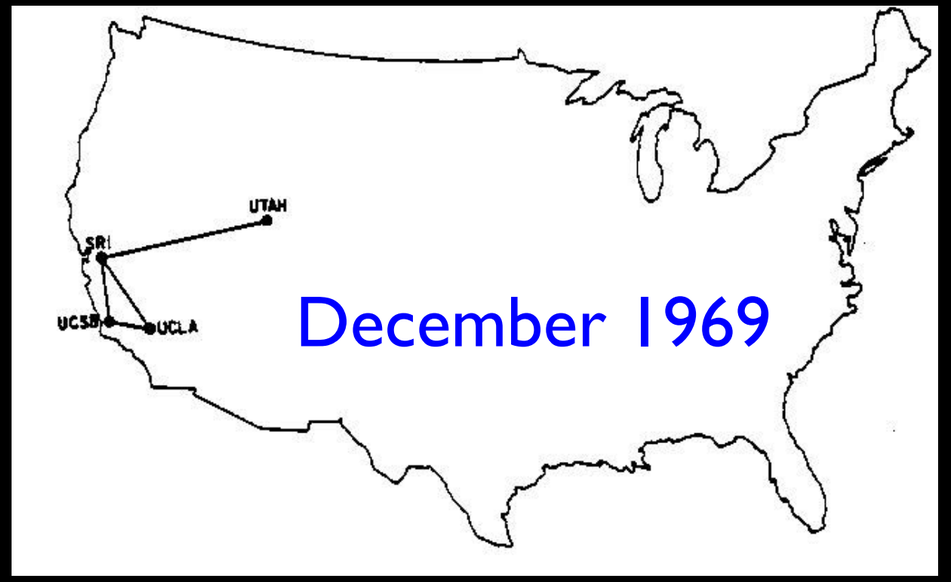
- Typically specialized in Mail
- E-Mail could make it across the country in 6-hours to about 2 days
- You generally focused your life on one computer
- Academic network in the 1980's

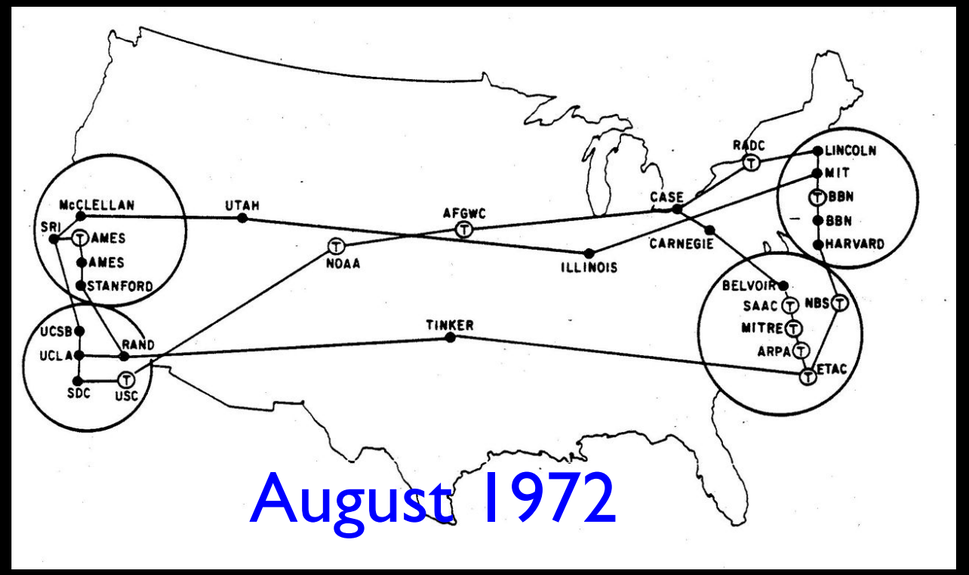
http://www.columbia.edu/acis/history/bitnet.jpg



Research Networks 1960-1980's

- How can we avoid having a direct connection between all pairs of computers or long snake-like connections?
- How can we dynamically handle outages switching between multiple paths?
- How to transport many messages simultaneously and efficiently?





http://som.csudh.edu/fac/lpress/history/arpamaps/

Efficient Message Transmission: Packet Switching

- Challenge: in a simple approach, like store-and-forward, large messages block small ones
- Break each message into packets
- Can allow the packets from a single message to travel over different paths, dynamically adjusting for use
- Use special-purpose computers, called routers, for the traffic control

Packet Switching - Postcards

Hello there, have a nice day.

Hello ther (1, csev, daphne)

e, have a (2, csev, daphne)

nice day. (3, csev, daphne)

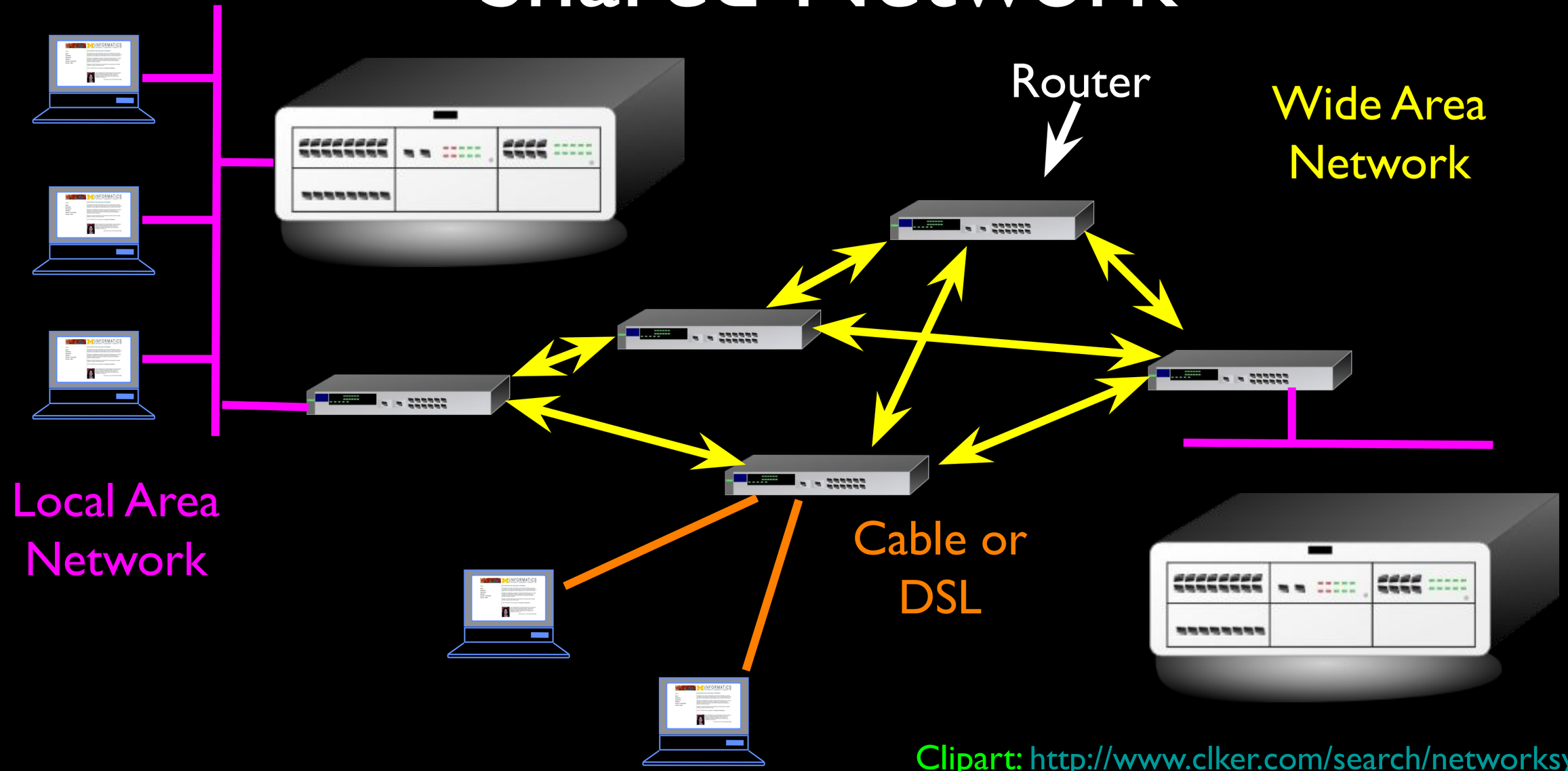
http://www.flickr.com/photos/stephoto/1519649375/

Packet Switching - Postcards

Hello there, have a nice day.

http://www.flickr.com/photos/stephoto/1519649375/

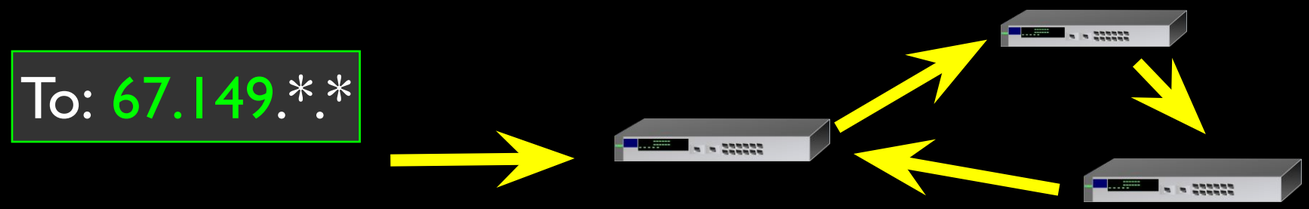
Shared Network



Clipart: http://www.clker.com/search/networksym/1

An Example Problem to Solve

- With each router having only a local / subset knowledge of the shape of the network, how do we avoid confusion if the information is a little "messed up"?



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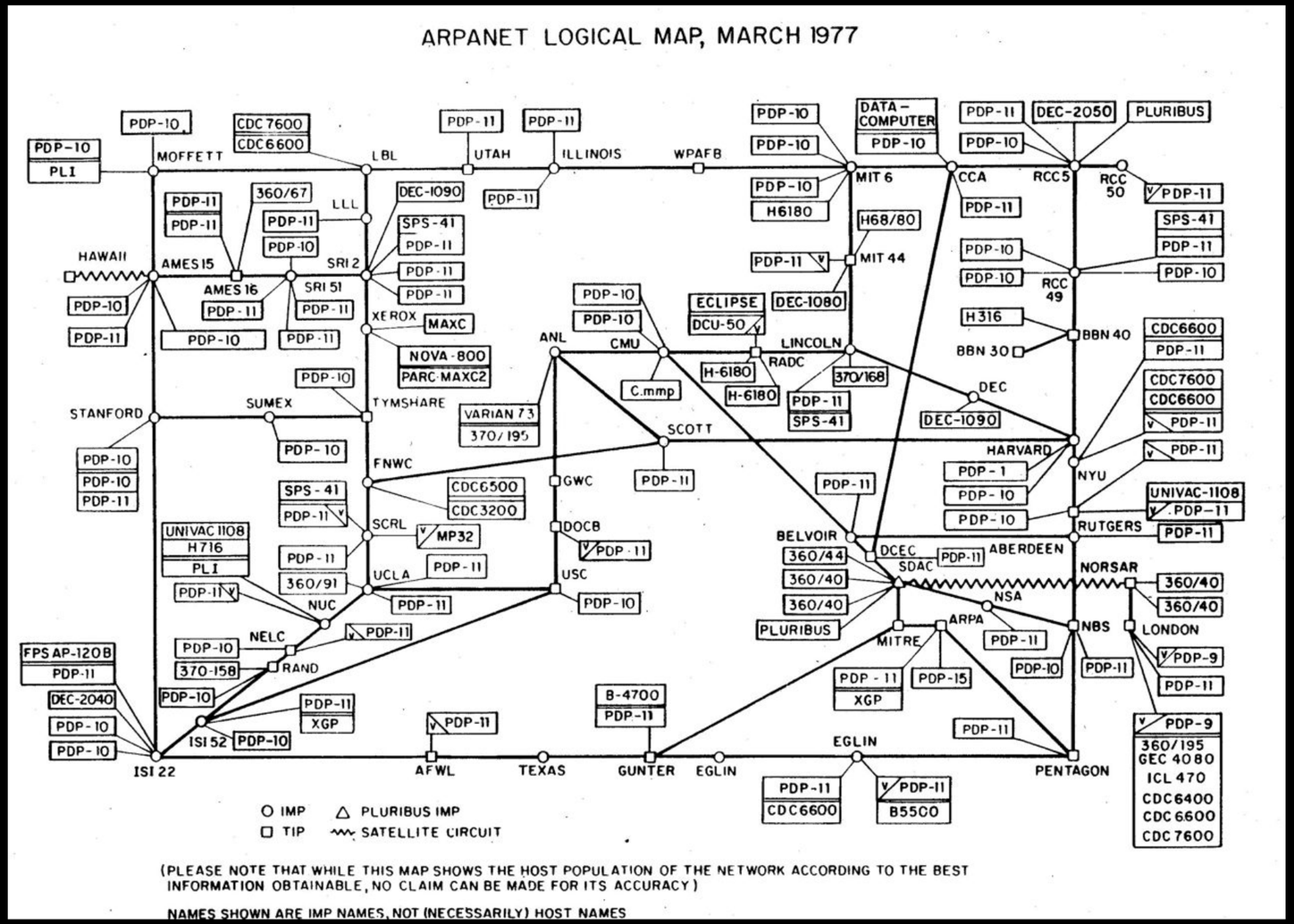
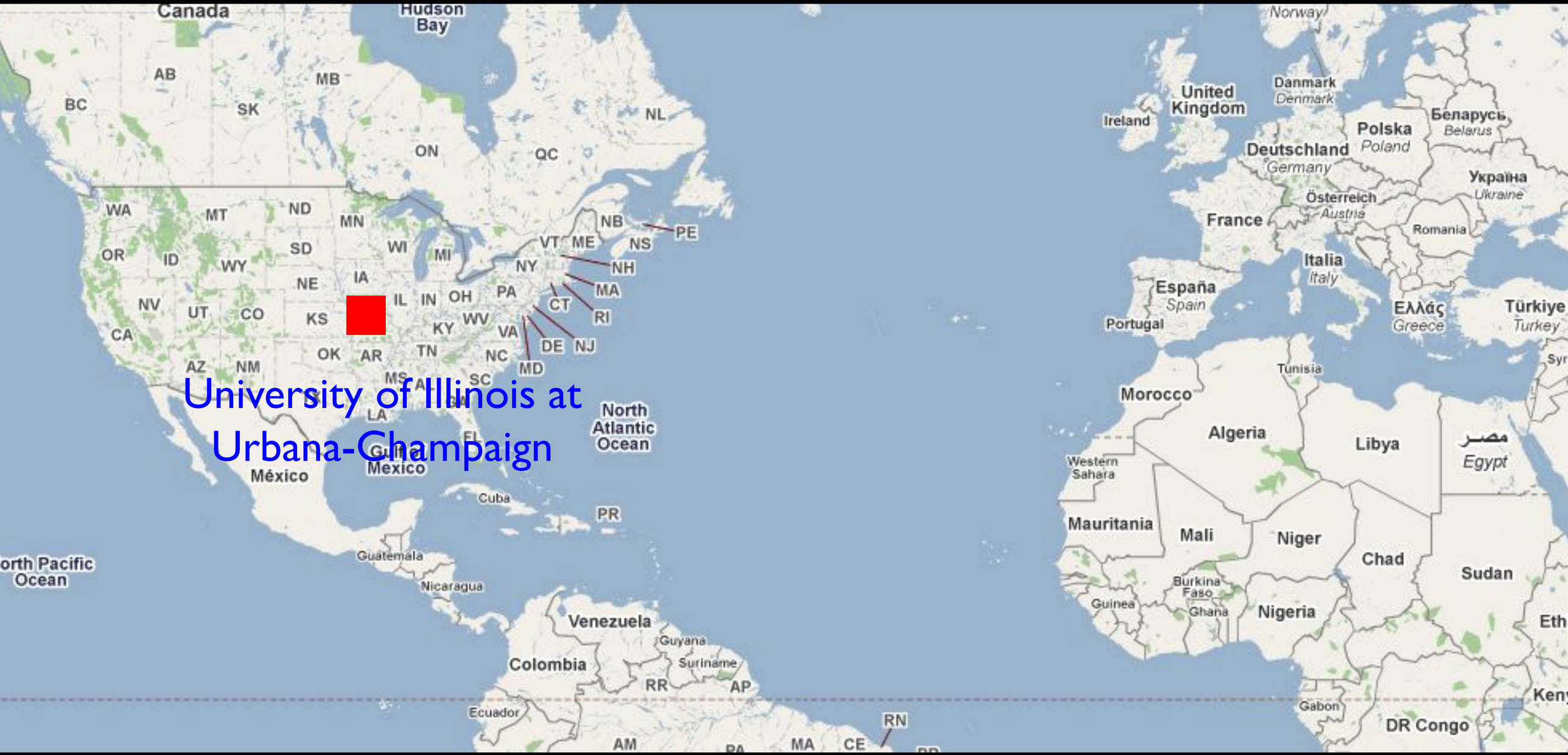


Heart, F., McKenzie, A., McQuillian, J., and Walden, D., ARPANET Completion Report, Bolt, Beranek and Newman, Burlington, MA, January 4, 1978.

http://som.csudh.edu/fac/lpress/history/arpamaps/arpanetmar77.jpg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Mauritania
Mali
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Chad
Sudan
Burkina Faso
Guinea
Ghana
Nigeria
Gabon
DR Congo

Supercomputers...

- As science needed faster and faster computers, more universities asked for their own Multimillion dollar supercomputer

- The National Science Foundation asked, "Why not buy a few supercomputers, and build up a national shared network?"

NCSA - Innovation

- We now "assume" the Internet and the Web - it was not so easy...

- A number of breakthrough innovations came from the National Center for Supercomputing Applications at Urbana-Champaign, Illinois

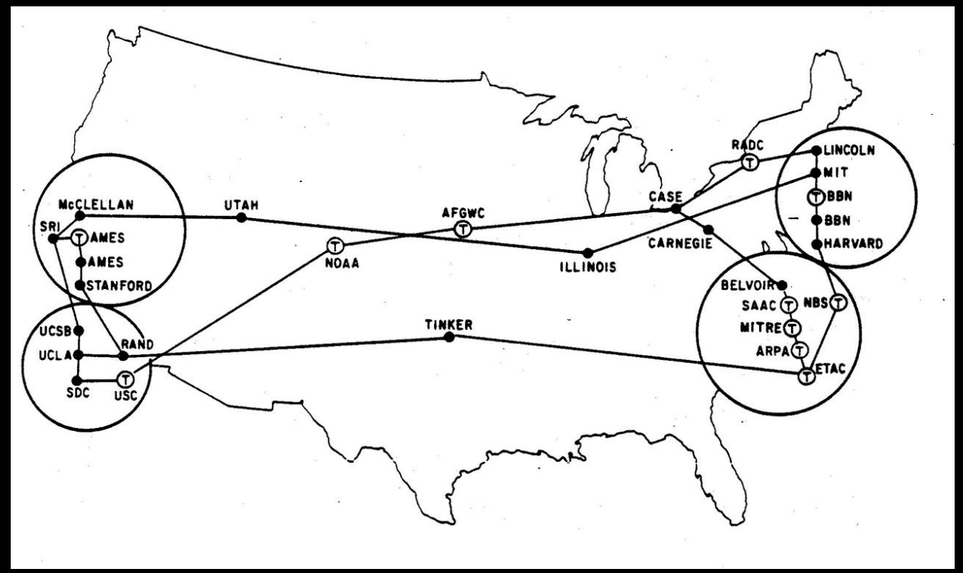
- High Performance Computing and the Internet were deeply linked

http://www.vimeo.com/6982439

(11:53)

NSF Net

- NSFNet was funded by the National Science Foundation
- Standardized on TCP/IP
- The first national TCP/IP network that was “inclusive”
- Initially the goal was all research universities



ARPANET August 1972

http://som.csudh.edu/fac/lpress/history/arpamaps/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University of Illinois at Urbana-Champaign
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FL
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Gulf of Mexico
México
Cuba
PR
Guatemala
Nicaragua
Venezuela
Guyana
Suriname
Colombia
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United Kingdom
Ireland
Danmark
Denmark
Беларусь
Belarus
Polska
Poland
Deutschland
Germany
Україна
Ukraine
Österreich
Austria
France
Romania
Italia
Italy
España
Spain
Portugal
Ελλάς
Greece
Türkiye
Turkey
Tunisia
Morocco
Algeria
Libya
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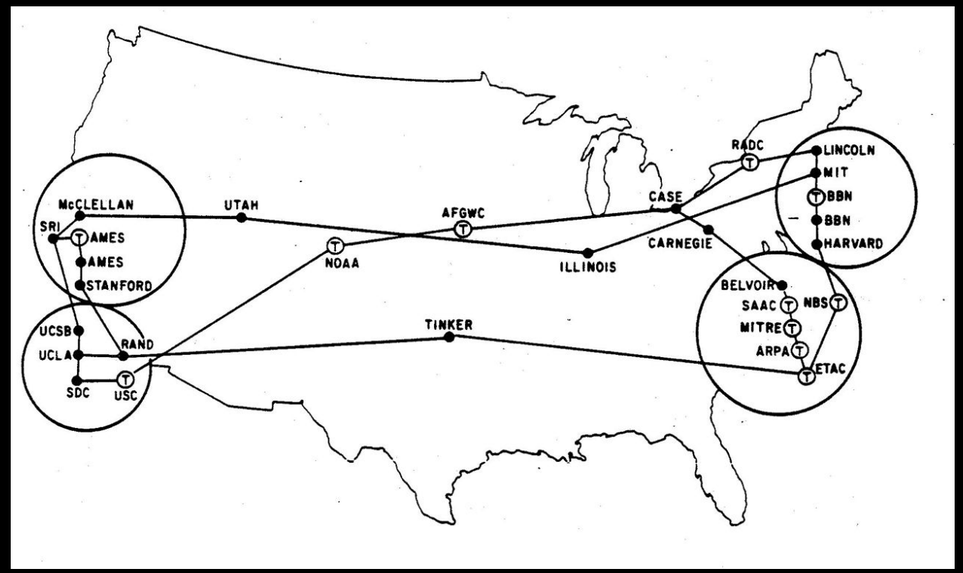


ARPANET August 1972

http://som.csudh.edu/fac/lpress/history/arpamaps/

Michigan's State-Wide Network

In 1969, Merit was one of the earliest network projects that was intended for use by an entire campus population of students, faculty, and alumni. [1]

Merit PDP-11Merit PDP-11 based Primary Communications Processor (PCP) at the University of Michigan, c. 1975

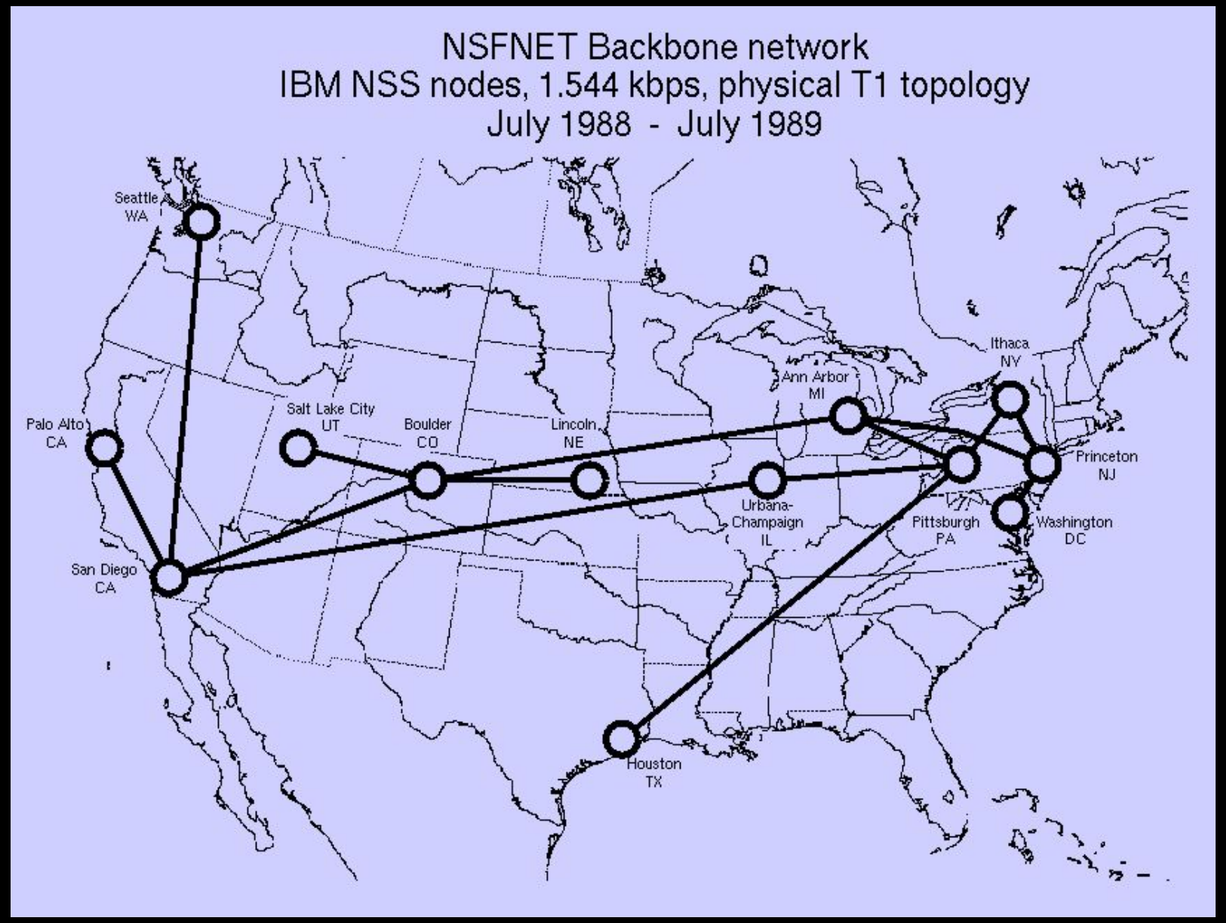
[1] http://www.zakon.org/robert/internet/timeline/

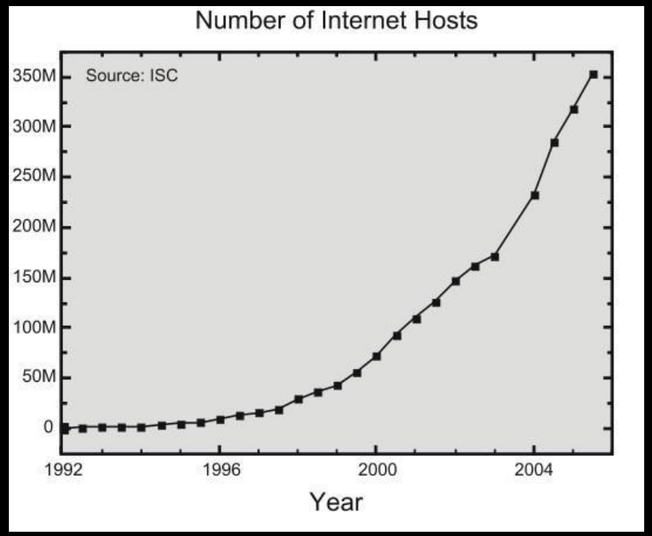
NSFNet @ University of Michigan

- University of Michigan did not get a Supercomputer Center
- Proposed a $55M high-speed network for $15M
- Partners: University of Michigan, Merit Network, IBM Corporation, MCI, and State of Michigan
- Operated from 1988-1995

http://www.vimeo.com/11044819

13:14





Source: http://hpwren.ucsd.edu/~hwb/NSFNET/NSFNET-20071ISummary/

NSFNET T1 Backbone and Regional Networks, 1991

http://virdir.ncsa.uiuc.edu/virdir/raw-material/networking/nsfnet/NSFNET_1.htm

NSF Net Advocacy

- Initially aimed at research universities
- Cleveland FreeNet and similar efforts provided indirect Internet access to the average citizen
- In about 1989-1990, the "academic-only" started being relaxed - led to Internet Service Providers making "dial-up Internet" available to the general public


University of Michigan
CERN
University of Illinois at
Urbana-Champaign

CERN - High-Energy (physics)

- Brilliant physicists from all over the world
- Work on long, highly detailed projects - 15-20 years
- Have a lot of time to think..
- (And have fun)

http://musiclub.web.cern.ch/MusiClub/bands/cernettes/

http://www.youtube.com/watch?v=A1L2xODZSI4

"...You Prefer your Collider"

Visits to CERN!

http://club-softball.web.cern.ch/club-softball/Canettes/

http://www.youtube.com/watch?v=f90ysF9BenI


Got My Mojo Working
Canettes Blues Band
with Dr. Chuck
Mr. Pickwick Pub

The Beginning of the Web: CERN

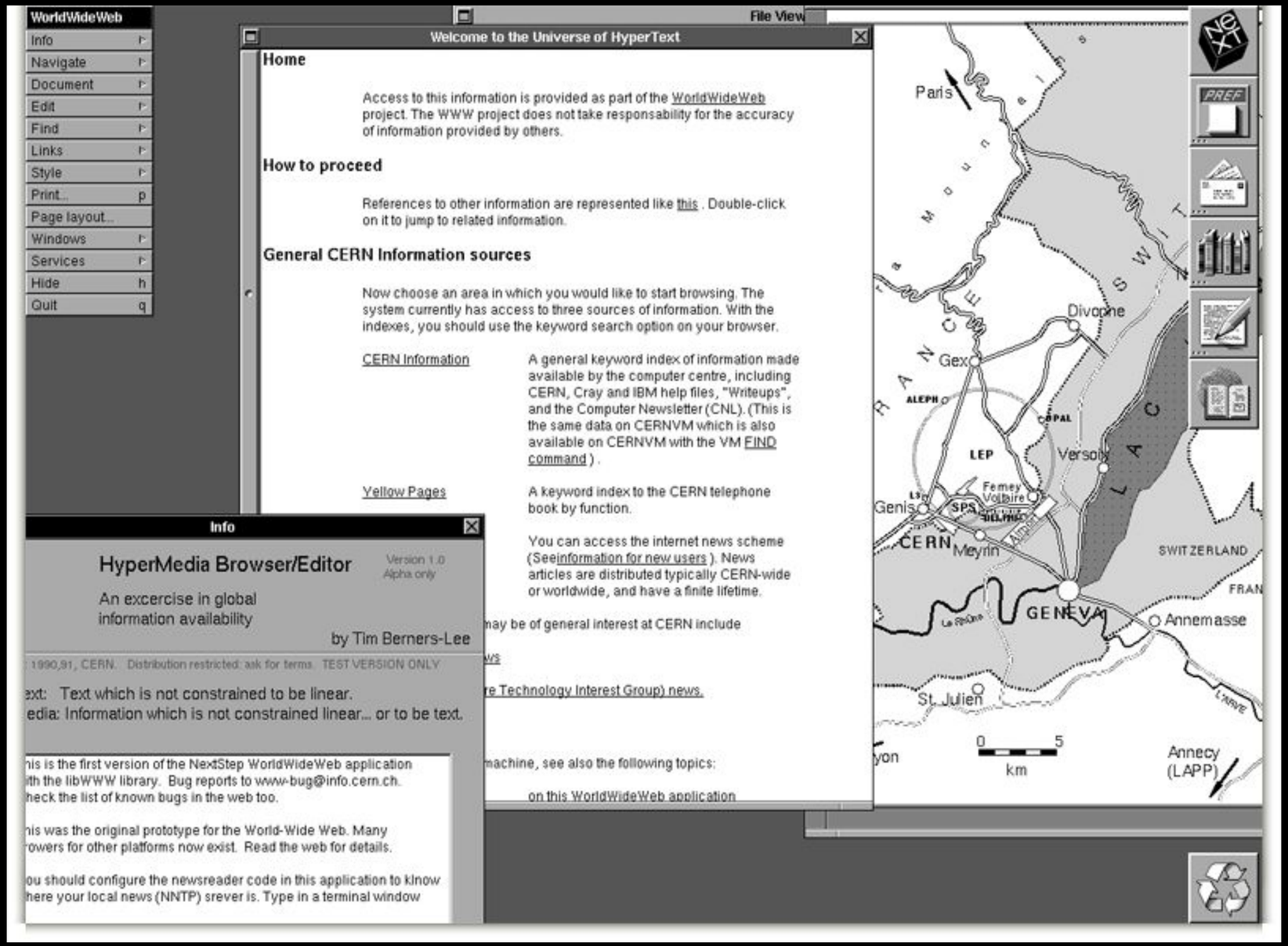
- The Internet was infrastructure - the web gave the Internet a “user interface and URLs

- The Web was invented at CERN by Tim Berners-Lee and Robert Cailliau

- CERN developed browsers and servers - with a goal of worldwide hyperlinked documents

http://www.youtube.com/watch?v=x2GyILq59rI

(9:42)



http://info.cern.ch/images/NextEditorBW.gif


University of Michigan
CERN
Stanford
University of Illinois at
Urbana-Champaign
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Hudson Bay
United Kingdom
Ireland
Norway
Danmark
Denmark
Беларусь
Belarus
Deutschland
Germany
Україна
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Österreich
Austria
France
Romania
Italia
Italy
España
Spain
Portugal
Ελλάς
Greece
Türkiye
Turkey
Tunisia
Morocco
Algeria
Libya
مصر
Egypt
Western Sahara
Mauritania
Mali
Niger
Chad
Sudan
Burkina Faso
Guinea
Ghana
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Gabon
DR Congo
North Atlantic Ocean
México
Gulf of Mexico
Cuba
PR
Guatemala
Nicaragua
Venezuela
Guyana
Suriname
Colombia
Ecuador
North Pacific Ocean
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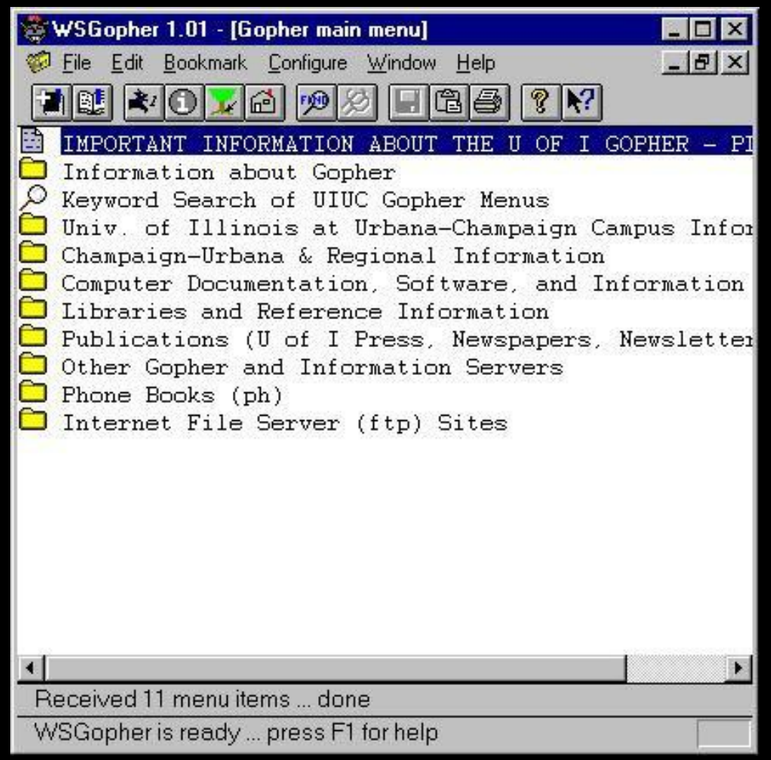
The First Web Server in America

- The first web server in America was at the Stanford Linear Accellerator (SLAC)
- It was a database of 300,000 research papers
- Dr. Paul Kunz
- December 12, 1991

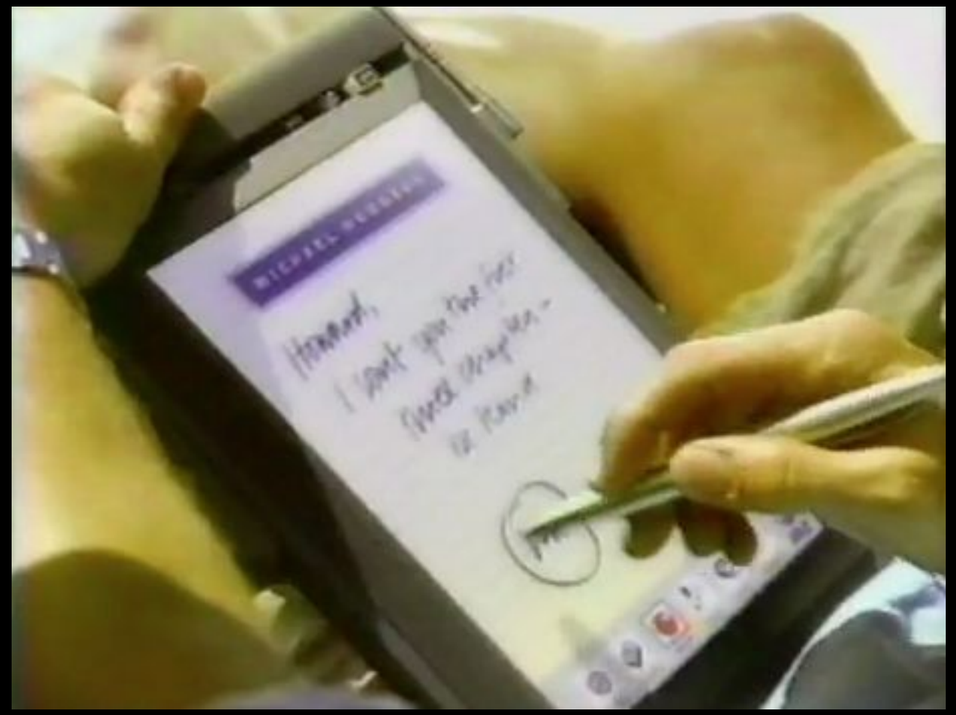
http://www.youtube.com/watch?v=IOgqP2yoKwc (5:30)

1993: Gopher is Dominant

- Internet Engineering Task Force (IETF) Meeting
  - March 29-April 2, 1993 - Columbus, Ohio, USA (638 attendees)
  - Gopher BOF - 200 attendees
  - World-Wide Web BOF - 15 attendees including Tim Berners-Lee
- P.S. DVD is invented this year



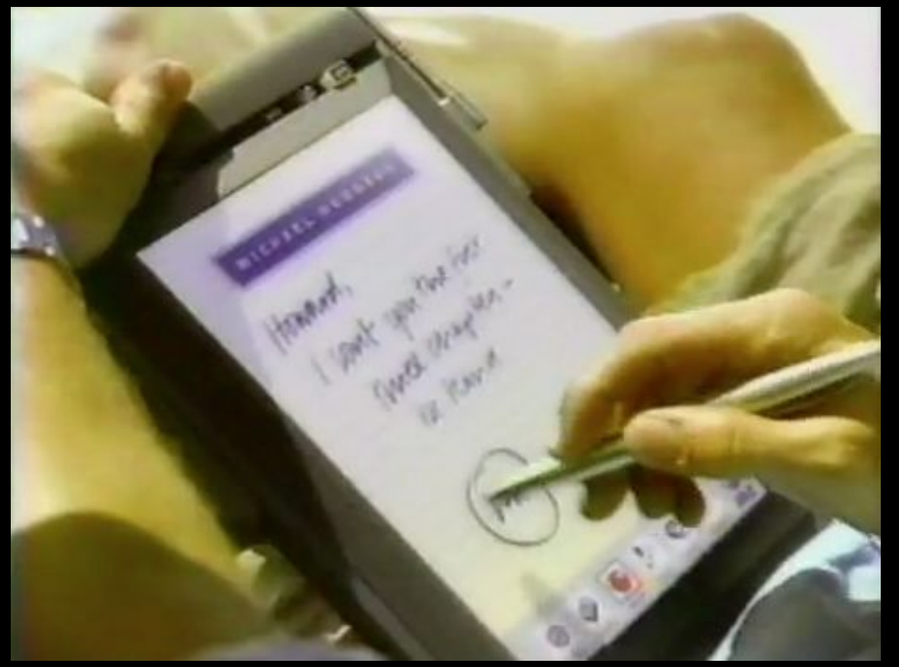
http://www.ietf.org/proceedings/26.pdf



What industry was thinking in 1993...

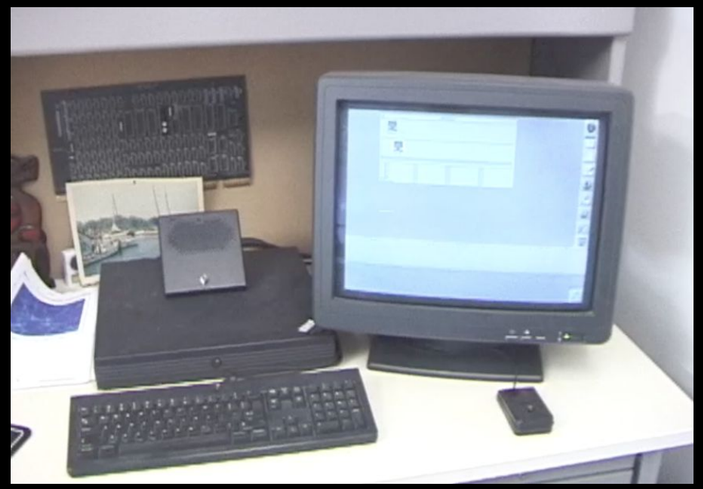
http://www.youtube.com/watch?v=sYNUcFMCIzw

0:30



Steve Jobs and the World-Wide-Web?

- For several years the primary web browser and web server were built as NeXT applications



- Apple computers provided far superior graphics that allowed the development of Mosaic

http://www.youtube.com/watch?v=W9rPUFW6czc


Dr. Robert Cailliau
CERN


University of Michigan
CERN
Stanford
University of Illinois at
Urbana-Champaign
Canada
Hudson Bay
United Kingdom
Ireland
Norway
Danmark
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Belarus
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Turkey
Tunisia
Morocco
Algeria
Libya
مصر
Egypt
Western Sahara
Mauritania
Mali
Niger
Chad
Sudan
Burkina Faso
Guinea
Ghana
Nigeria
Gabon
DR Congo
North Atlantic Ocean
México
Gulf of Mexico
Cuba
PR
Guatemala
Nicaragua
Venezuela
Guyana
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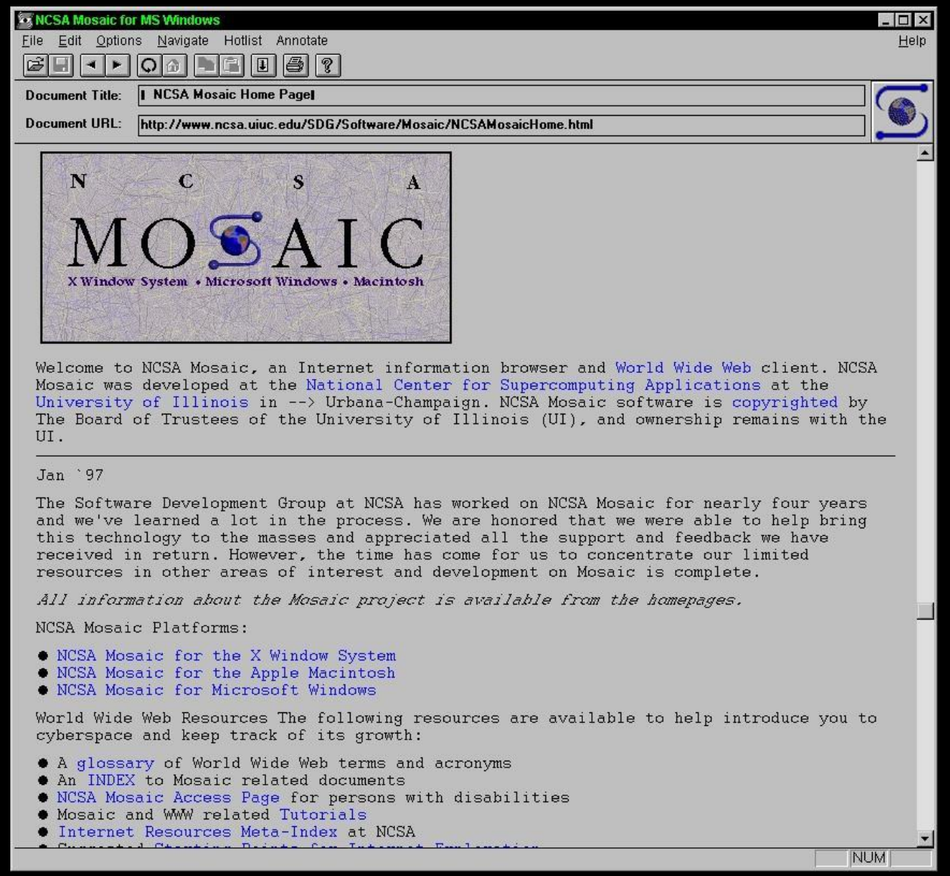
The Explosive Growth of the Web

- The web was invented in the early 1990's
- Growing in Academia 1993
- Growing everywhere 1994 - 1995
- Cable Modems to the home started in the mid 1990's



http://gladiator.ncsa.uiuc.edu/Images/press-images/mosaic.1.0.tif

Mosaic - Netscape - Mozilla - Firefox

- Mosaic was the first "consumer" web browser developed at NCSA

- NCSA created the httpd web server which is the basic for the Apache web server

- While most of the NCSA programmers formed Netscape and made their fortunes, NCSA released their browser for free and focused on building standards to keep the web open

http://www.vimeo.com/7053726 9:01

1994: Year of the Web

- Netscape Founded - April 4, 1994
- WWW Conf: May 25-26-27 1994, CERN, Geneva (Switzerland)
- WWW Conf: October 17-19, 1994, Chicago, IL
- October 1994, Tim Berners-Lee founded the (W3C) at MIT
- November 8, 1994 - Windows 95 beta 2 - With a vengance!

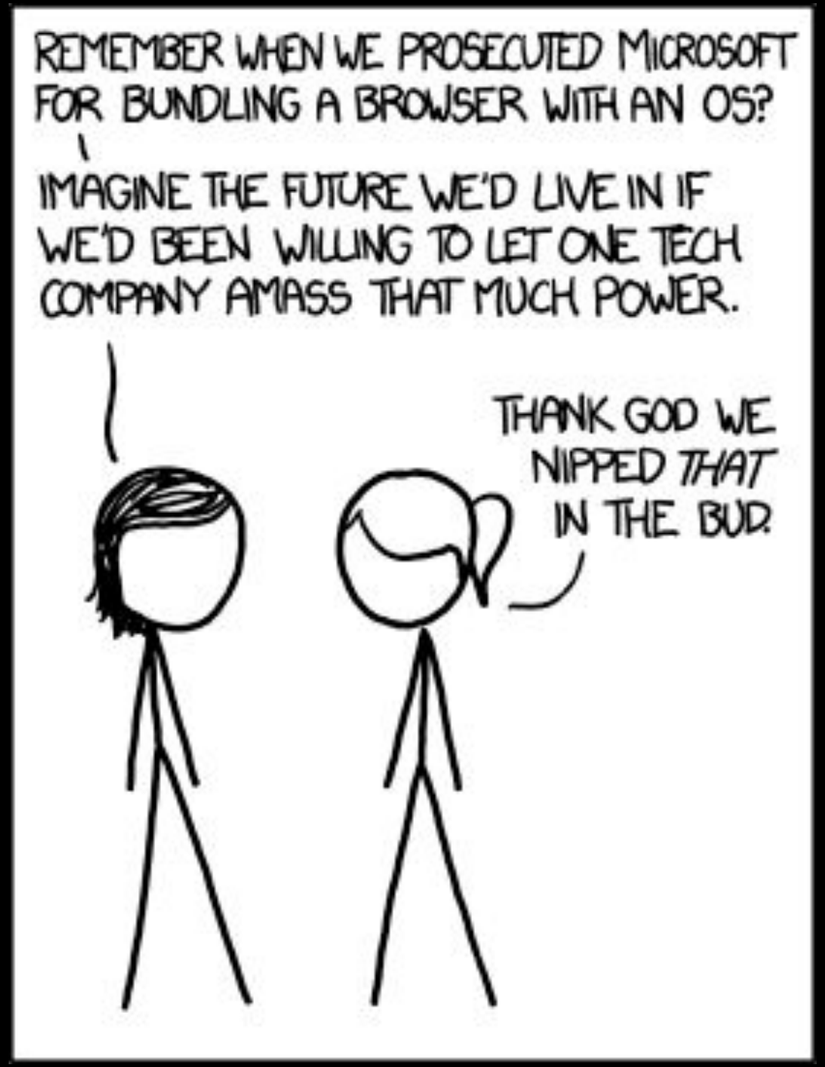
Netscape, JavaScript and FireFox

- As Microsoft worked to suffocate Netscape::
  - JavaScript was invented to compete with Visual Basic (1995)
  - Netscape slowly leaked out into Open Source as Mozilla - which later became FireFox (late 1990's)
  - FireFox's search box gave the small Mozilla Foundation millions of revenue

http://www.youtube.com/watch?v=IPxQ9kEaf8Q

Did Microsoft Save the World-Wide Web?

- Netscape wanted to make the web browser, web server, and web protocols propritary and owned by them
- The web browser would be $50-$100 and sold separately
- This threatened to make the desktop operating system irrelevant



http://xkcd.com/1118/

World-Wide-Web Consortium

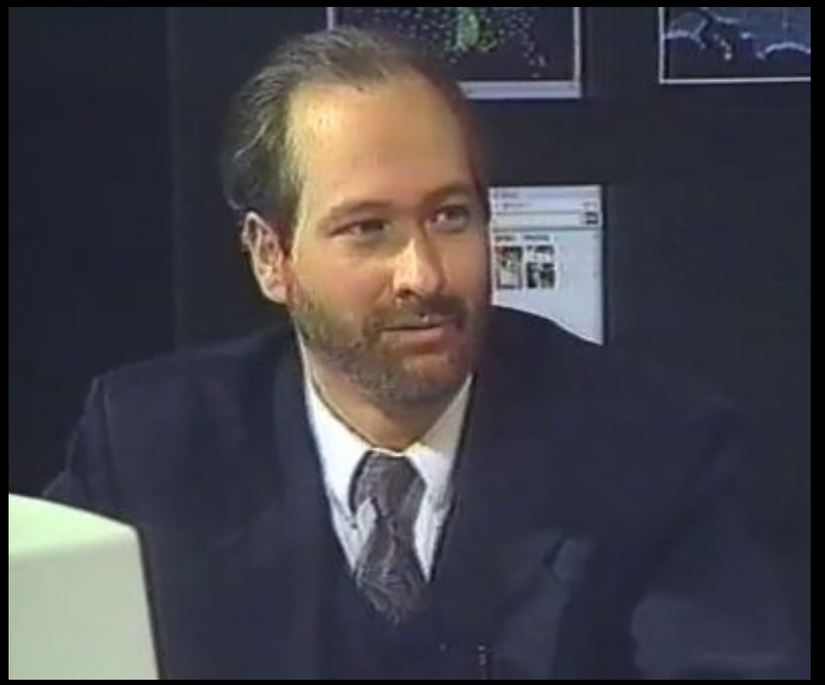
- The W3C was formed in October 1994 (www.w3c.org)
- Led by Tim Berners-Lee who moved from CERN to MIT
- Goal was to develop standards for the web and avoid proprietary balkanization of the Web
- Many large companies (Microsoft, IBM, etc) joined quickly

http://en.wikipedia.org/wiki/World_Wide_Web_Consortium

When You Can Assume the Web

Internet: TCI Show 08
http://www.vimeo.com/4275919

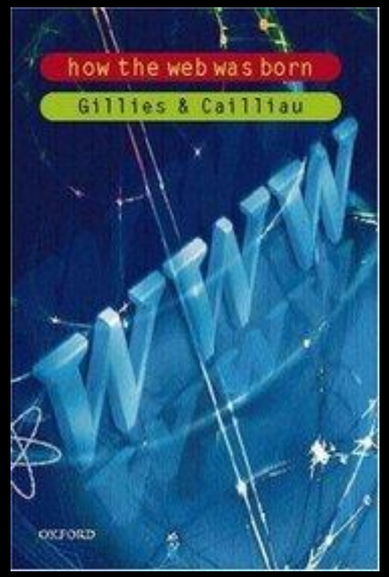
December 11-14, 1995
http://www.w3.org/Conferences/WWW4/

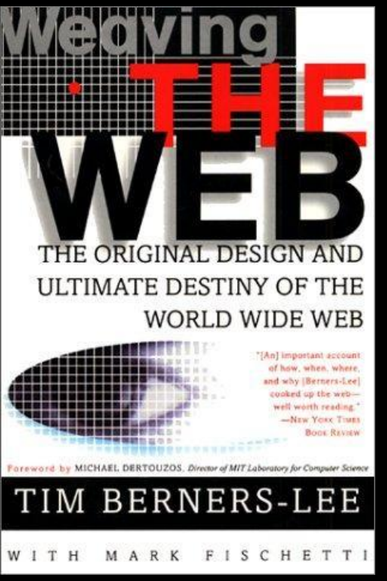


Some Great Books

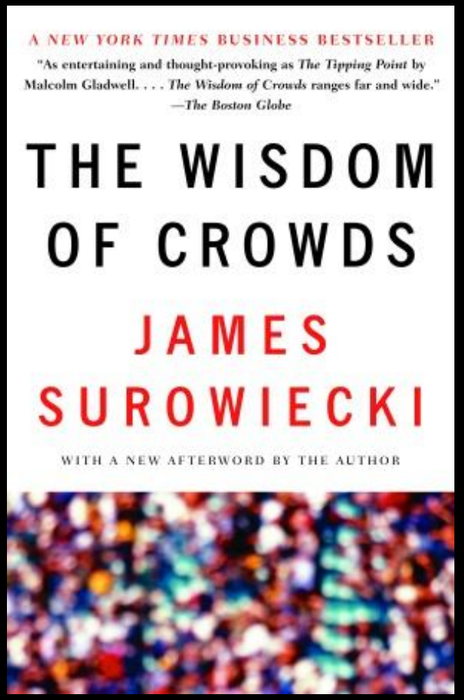
- How the Web was Born: The Story of the World Wide Web, James Gillies , Robert Cailliau

- Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web, Tim Berners-Lee





- Larry Smarr wanted to make supercomputers available to physicists
- Unversity of Michigan sneaked in 1.54Mb/sec instead of 56kb/sec backbone for their NSFNet proposal
- Tim Berners-Less and Robert Cailliau were building a system for network hosted documentation
- Paul Kunz was trying to make his article database easier to use
- Joseph Hardin wanted to make supercomputers more user friendly
- Mitchell Baker - Just wanted us to have a free and open source



The Web Land Rush...

- In the late 1990's there were many fortunes to be made - simply by being first in a market
- Everything was "novel" when it was re-invented on the web
- New brands were quickly established and became dominant

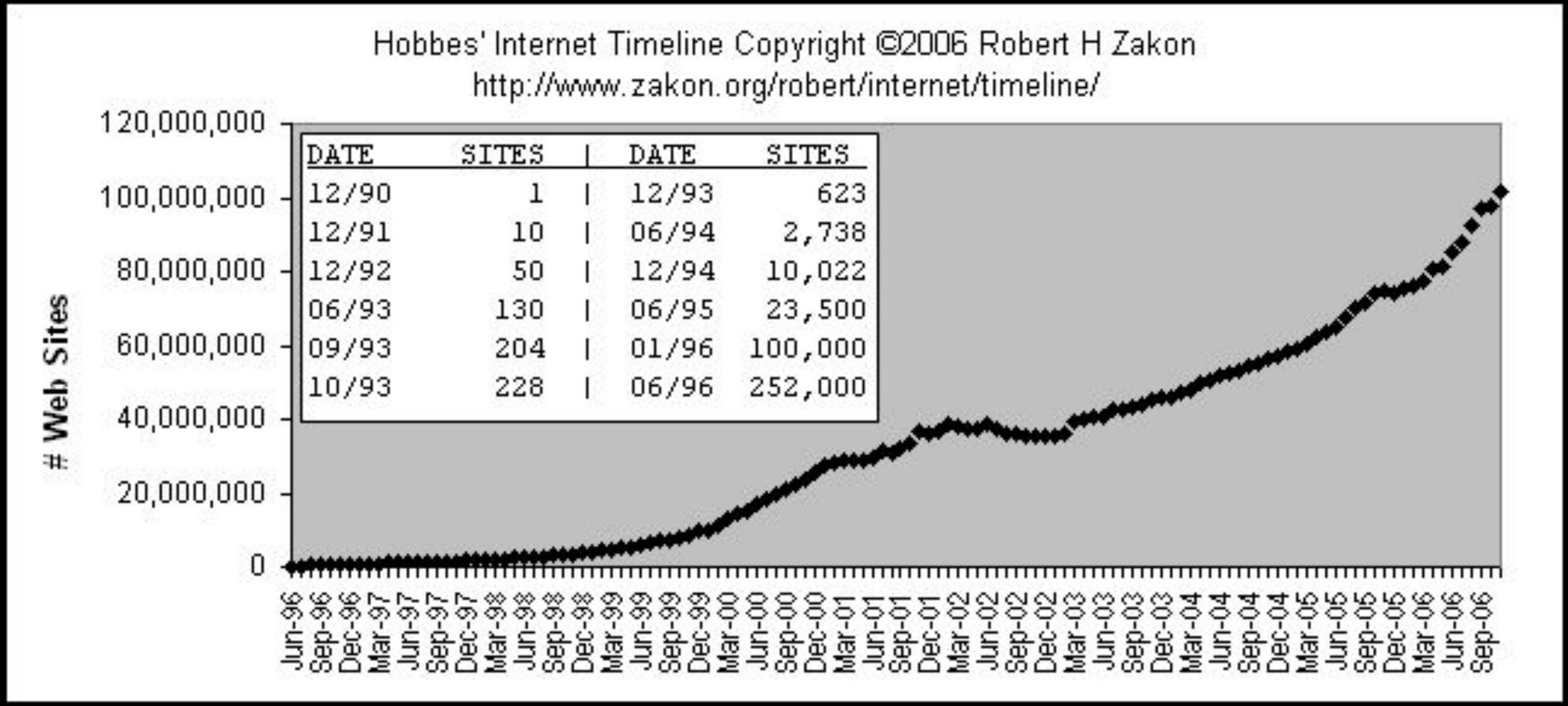
http://www.vimeo.com/7048422

5:39

The Modern Internet

- In the late 1990's in the boom there was a great deal of Fiber optic that was installed in the US
- High speed and long distance were cheap and common
- Many national backbone networks emerged - commercial, government, academic, etc
- These networks swap data at "peering points" so we see one seamless Internet - after about 1999 - this was all pretty boring - it just worked

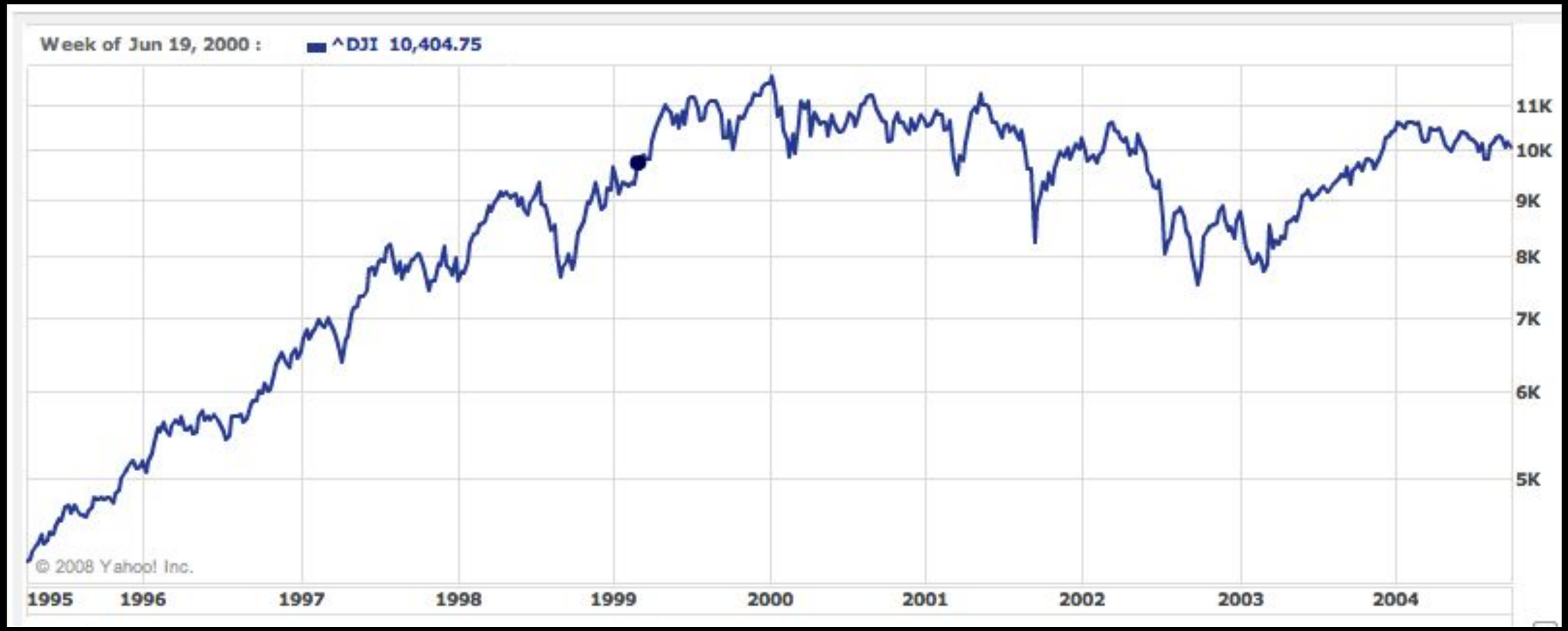
http://en.wikipedia.org/wiki/Internet_Exchange_Point



DATE	SITES	DATE	SITES
12/90	1	12/93	623
12/91	10	06/94	2,738
12/92	50	12/94	10,022
06/93	130	06/95	23,500
09/93	204	01/96	100,000
10/93	228	06/96	252,000

http://www.zakon.org/robert/internet/timeline/

The "Web Effect"



A History of Open Source ....

http://www.vimeo.com/7307422

http://www.vimeo.com/3800796

http://www.vimeo.com/6215179

Other Resources

- Hobbes Internet Timeline
  - http://www.zakon.org/robert/internet/timeline/
- A Brief History of the Internet. Barry M. Leiner, et al. 2009. SIGCOMM Comput. Commun. Rev. 39, 5 (October 2009), 22-31. DOI=10.1145/1629607.1629613
  - http://doi.acm.org.proxy.lib.umich.edu/10.1145/1629607.1629613

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