

Internet History

Charles Severance



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

Coursera

Unless otherwise noted, the content of these slides are licensed under a Creative Commons Attribution 3.0 License.

<http://creativecommons.org/licenses/by/3.0/>.

Copyright 2009- Charles Severance.

You assume all responsibility for use and potential liability associated with any use of the material. Material contains copyrighted content, used in accordance with U.S. law. Copyright holders of content included in this material should contact open.michigan@umich.edu with any questions, corrections, or clarifications regarding the use of content. The Regents of the University of Michigan do not license the use of third party content posted to this site unless such a license is specifically granted in connection with particular content. Users of content are responsible for their compliance with applicable law. Mention of specific products in this material solely represents the opinion of the speaker and does not represent an endorsement by the University of Michigan. For more information about how to cite these materials visit <http://michigan.educommons.net/about/terms-of-use>.

Any medical information in this material is intended to inform and educate and is not a tool for self-diagnosis or a replacement for medical evaluation, advice, diagnosis or treatment by a healthcare professional. You should speak to your physician or make an appointment to be seen if you have questions or concerns about this information or your medical condition. Viewer discretion is advised: Material may contain medical images that may be disturbing to some viewers.

Copyright Thanks

- Thanks to IEEE Computer for permission 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

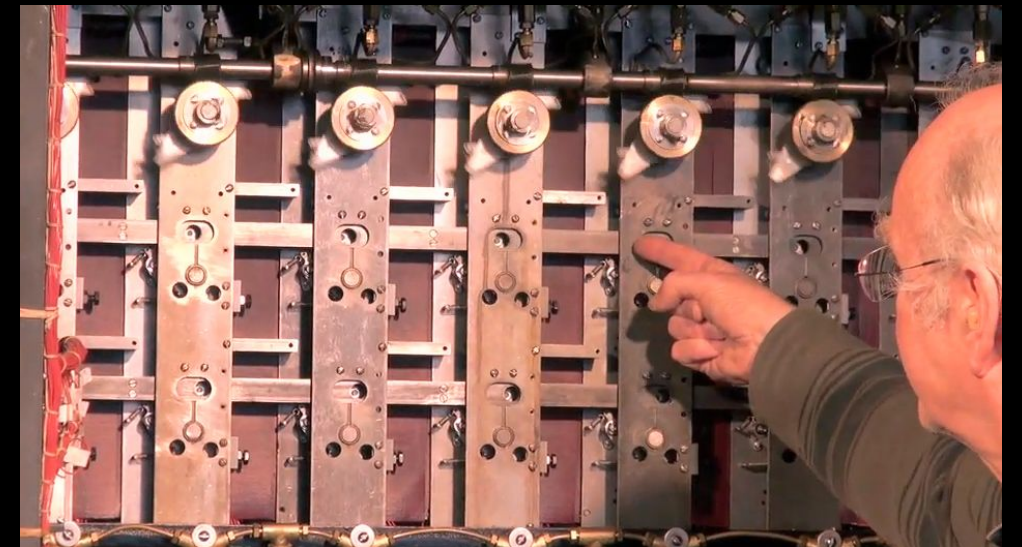
High Level Phases

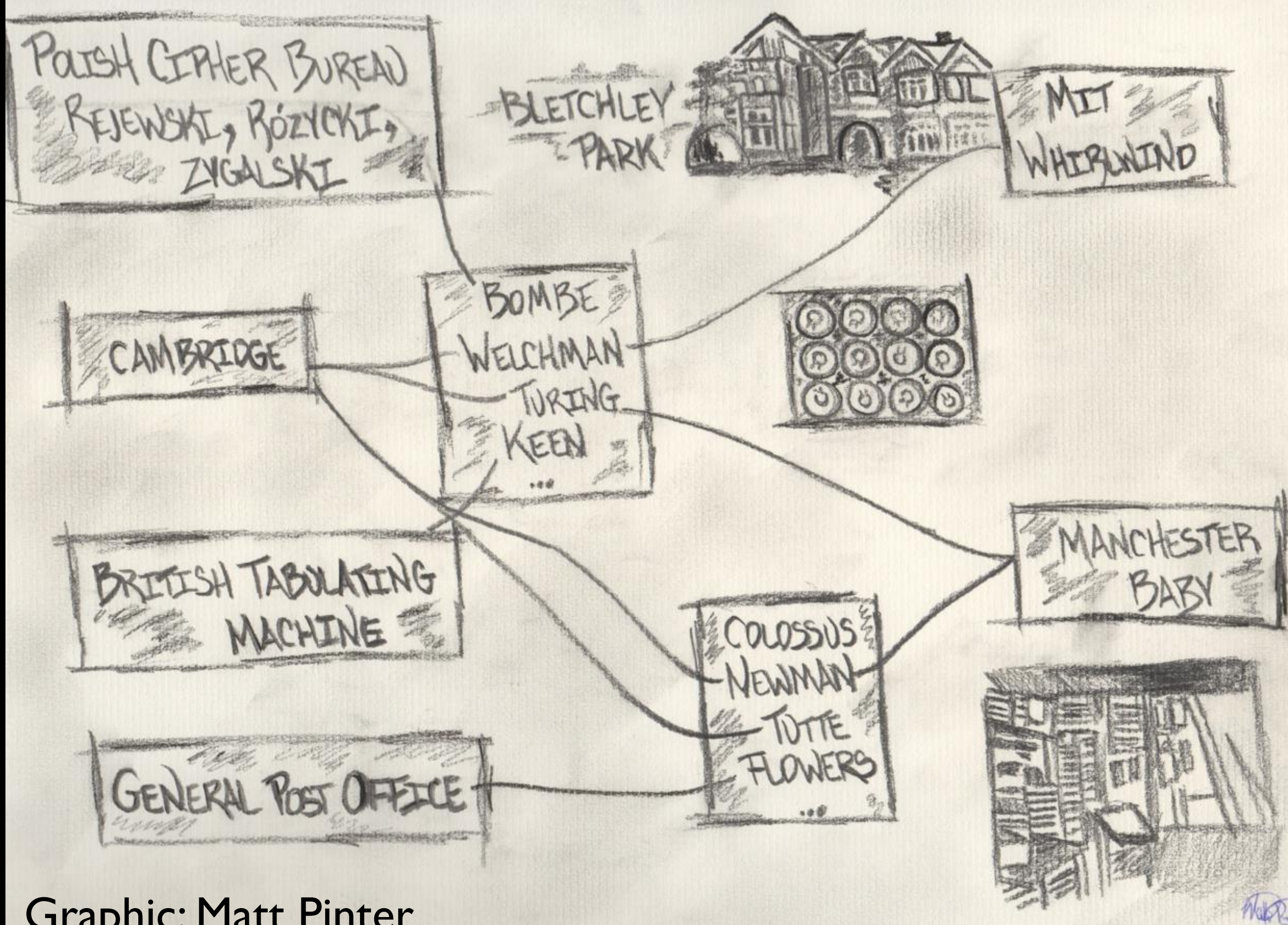
- Dawn of Electronic Computing
- Pre-Internet Communication
- Research Networks - 1960s - 1970's
- The First "Internet" - Mid 1980's
- The Web Makes it Easy - Early 1990's
- Ubiquity of the Internet - 1996 and beyond

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_ft0LfIs





Graphic: Matt Pinter

Post-War (1940s)

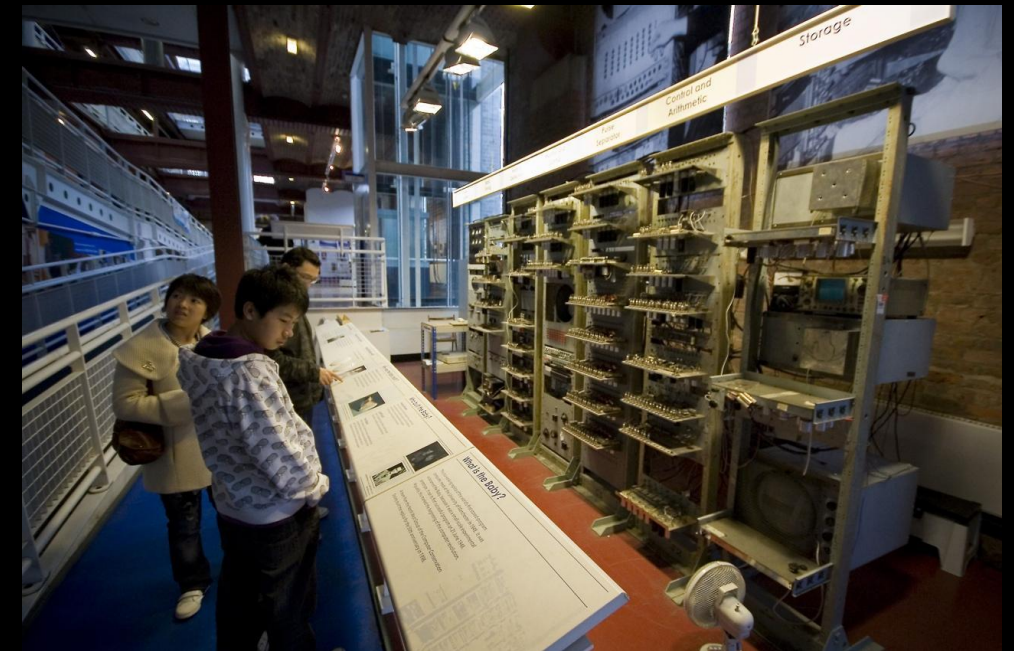
- Alumni of the US and UK codebreaking efforts and other started building general purpose computers

- Manchester Baby

- Ferranti Mark I

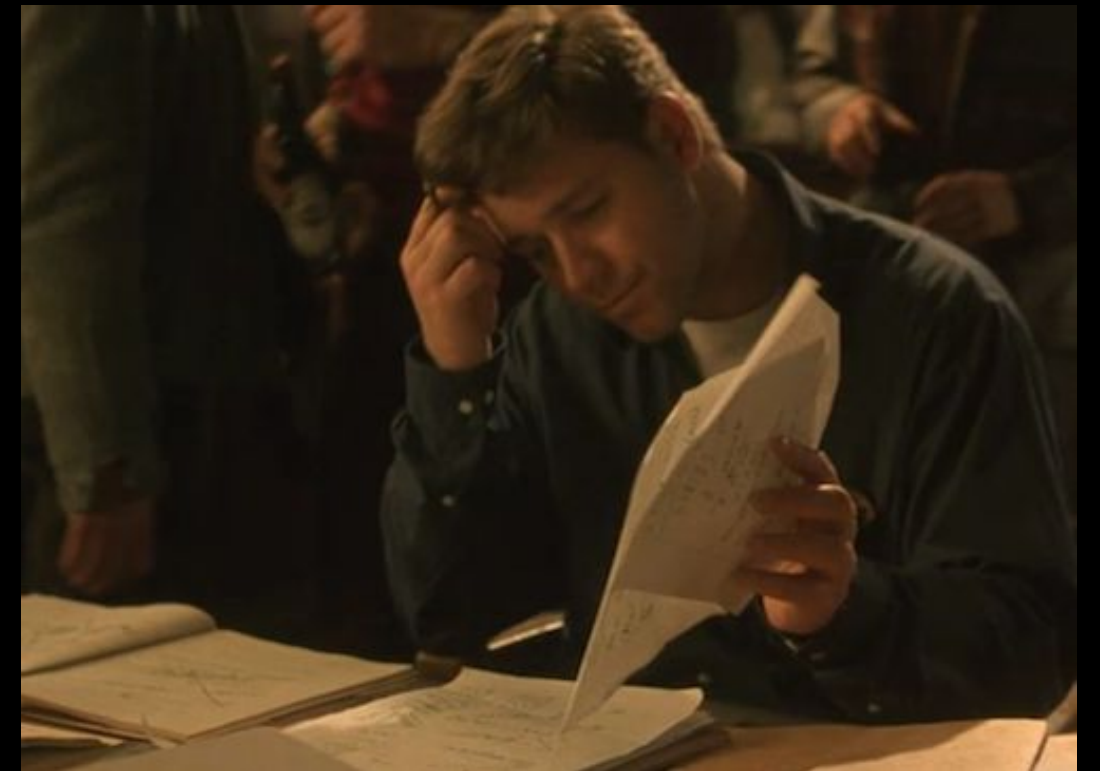
- Harvard Mark I

- US Army ENIAC



Post-War (1950s)

- Math / Science “Won the war”
- Broad-based investment in maintaining the US/West intellectual lead
- Mathematicians 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>

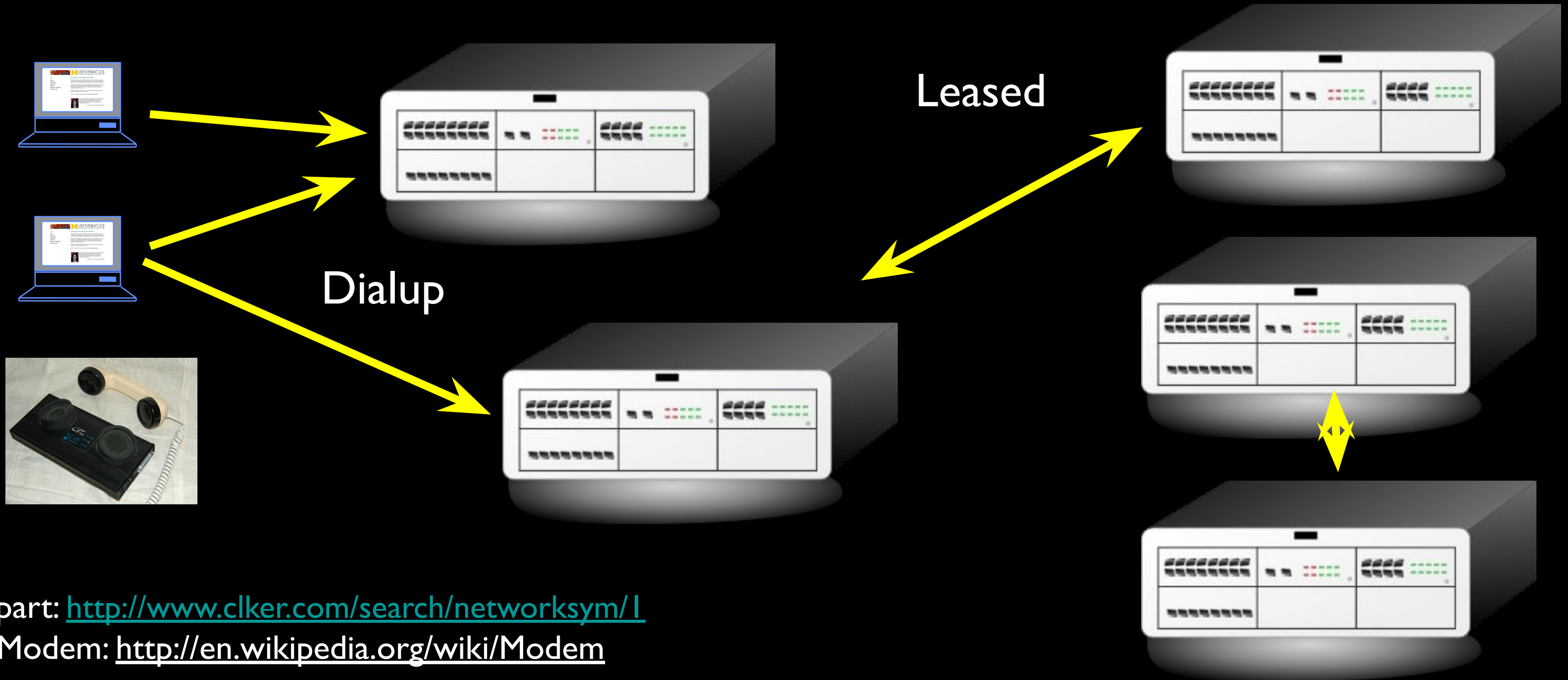
John Forbes Nash

- 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



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



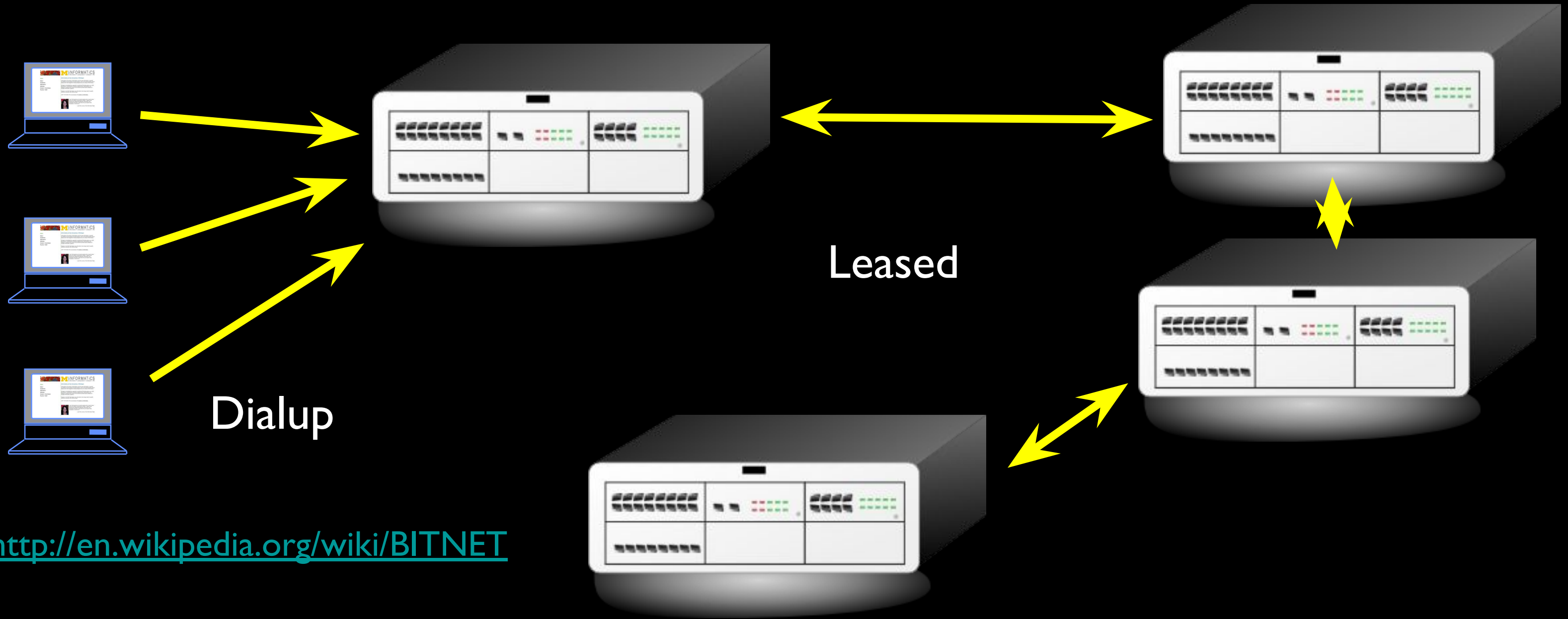
<http://deepblue.lib.umich.edu/handle/2027.42/79576> (1969)

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

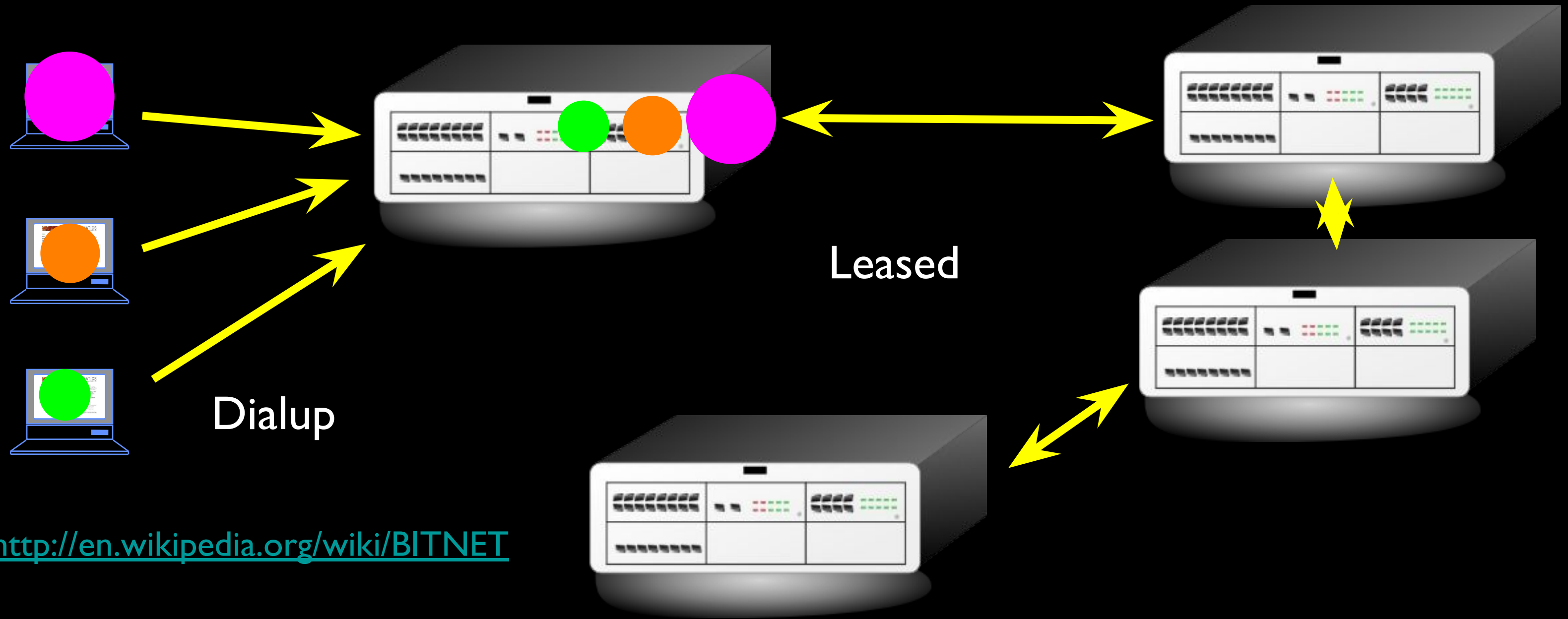
Store and Forward Networking



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

Clipart: <http://www.clker.com/search/networksym/>

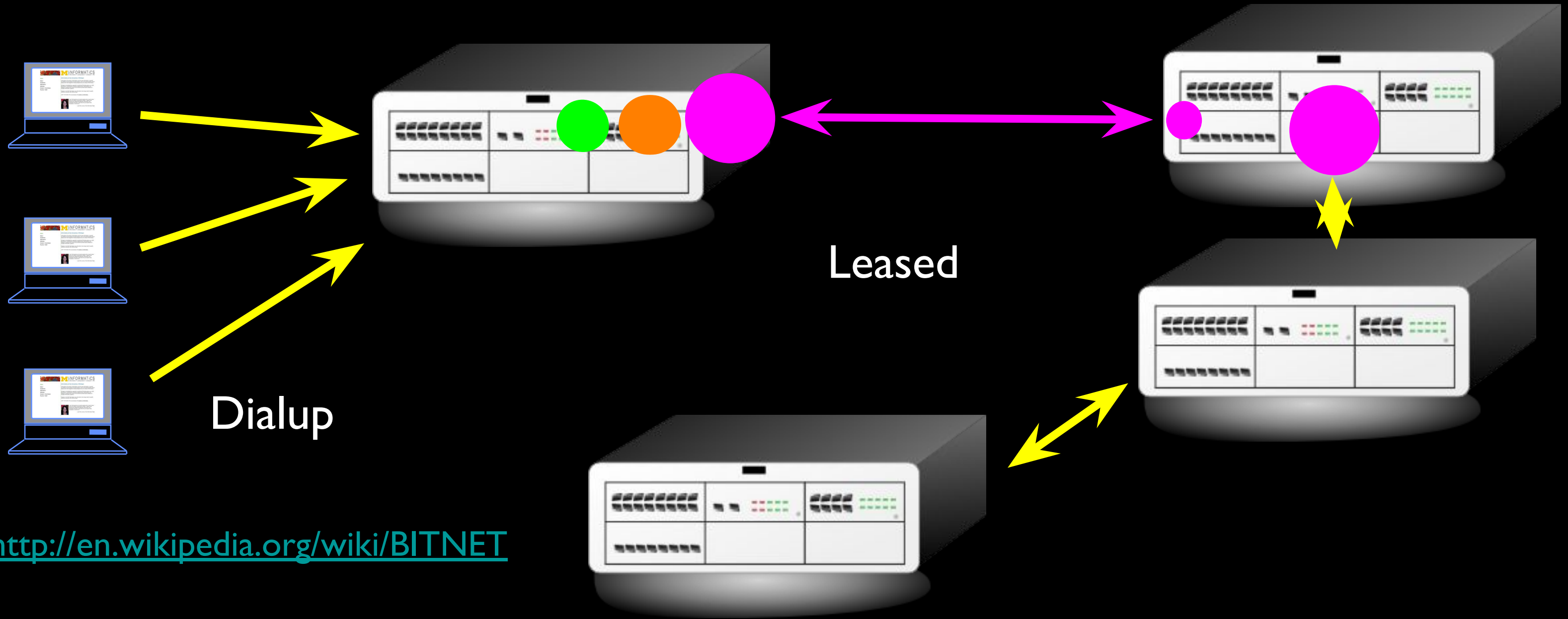
Store and Forward Networking



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

Clipart: <http://www.clker.com/search/networksym/>

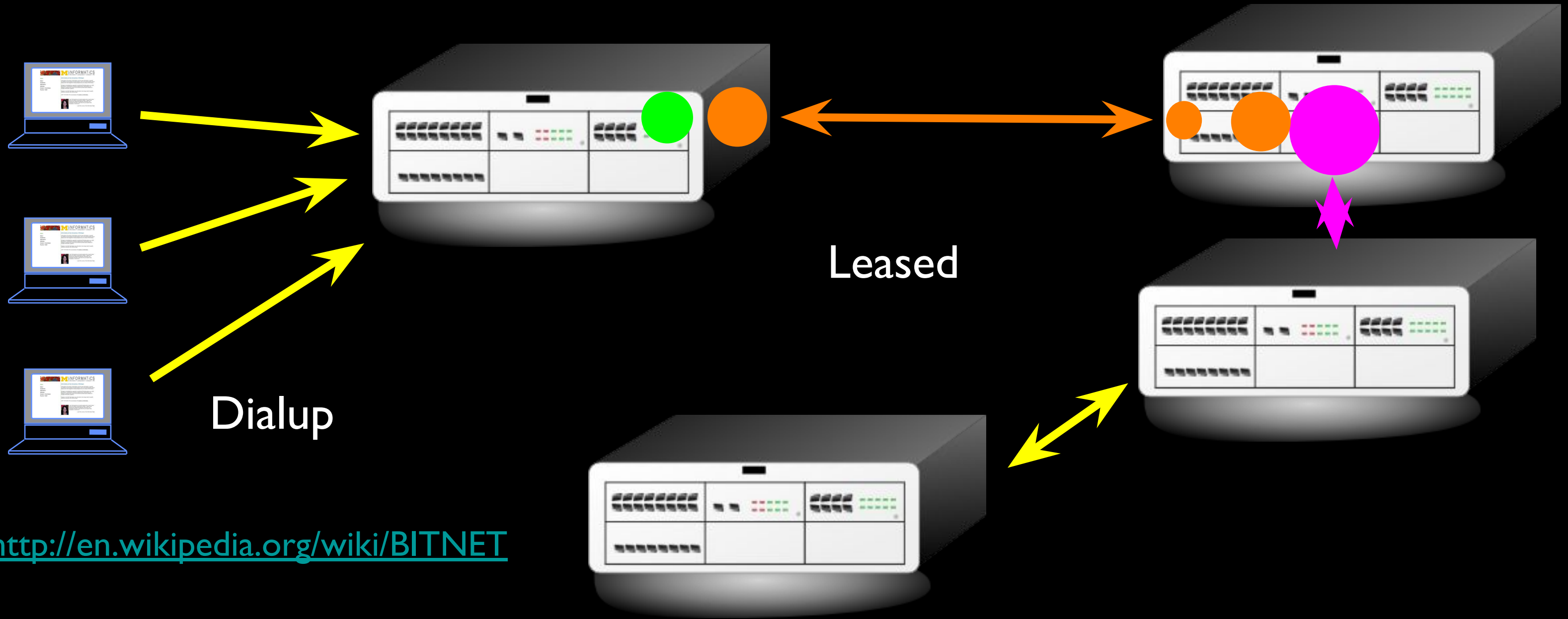
Store and Forward Networking



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

Clipart: <http://www.clker.com/search/networksym/>

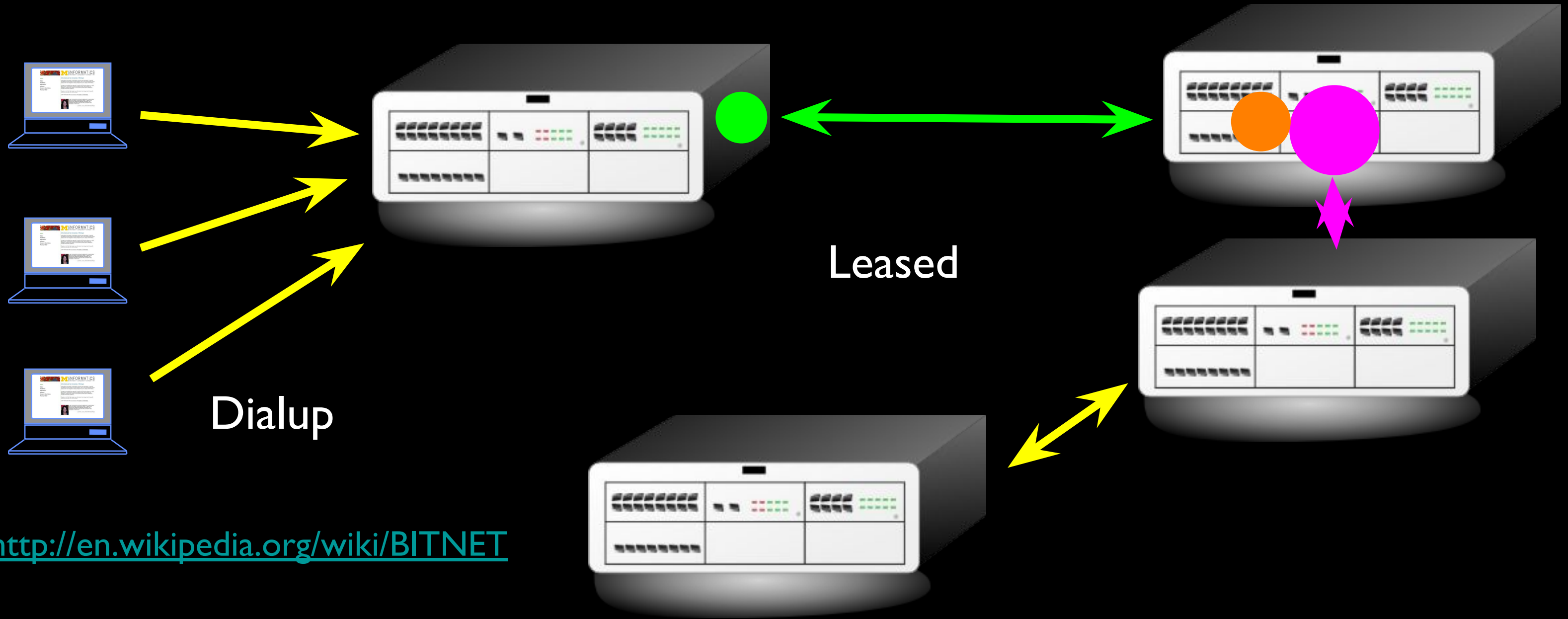
Store and Forward Networking



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

Clipart: <http://www.clker.com/search/networksym/>

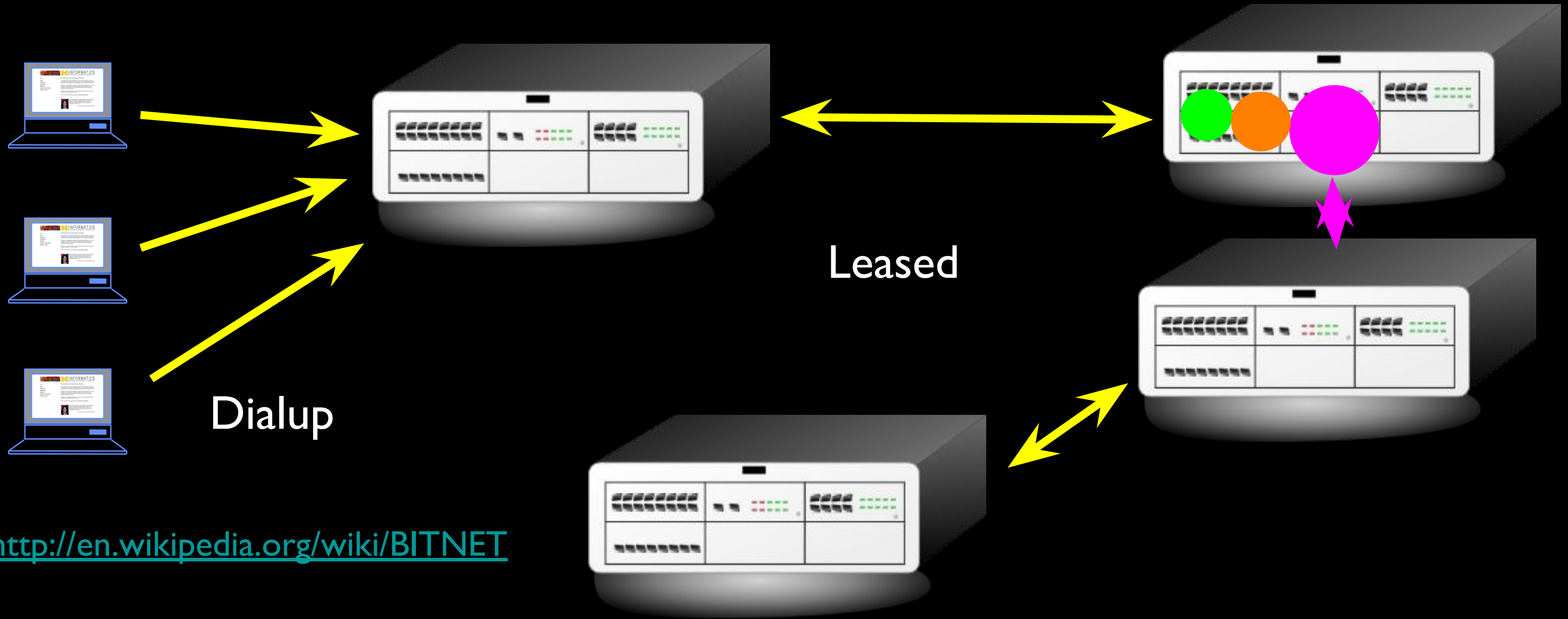
Store and Forward Networking



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

Clipart: <http://www.clker.com/search/networksym/>

Store and Forward Networking



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

Clipart: <http://www.clker.com/search/networksym/>



Saving Money with
More "Hops"



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

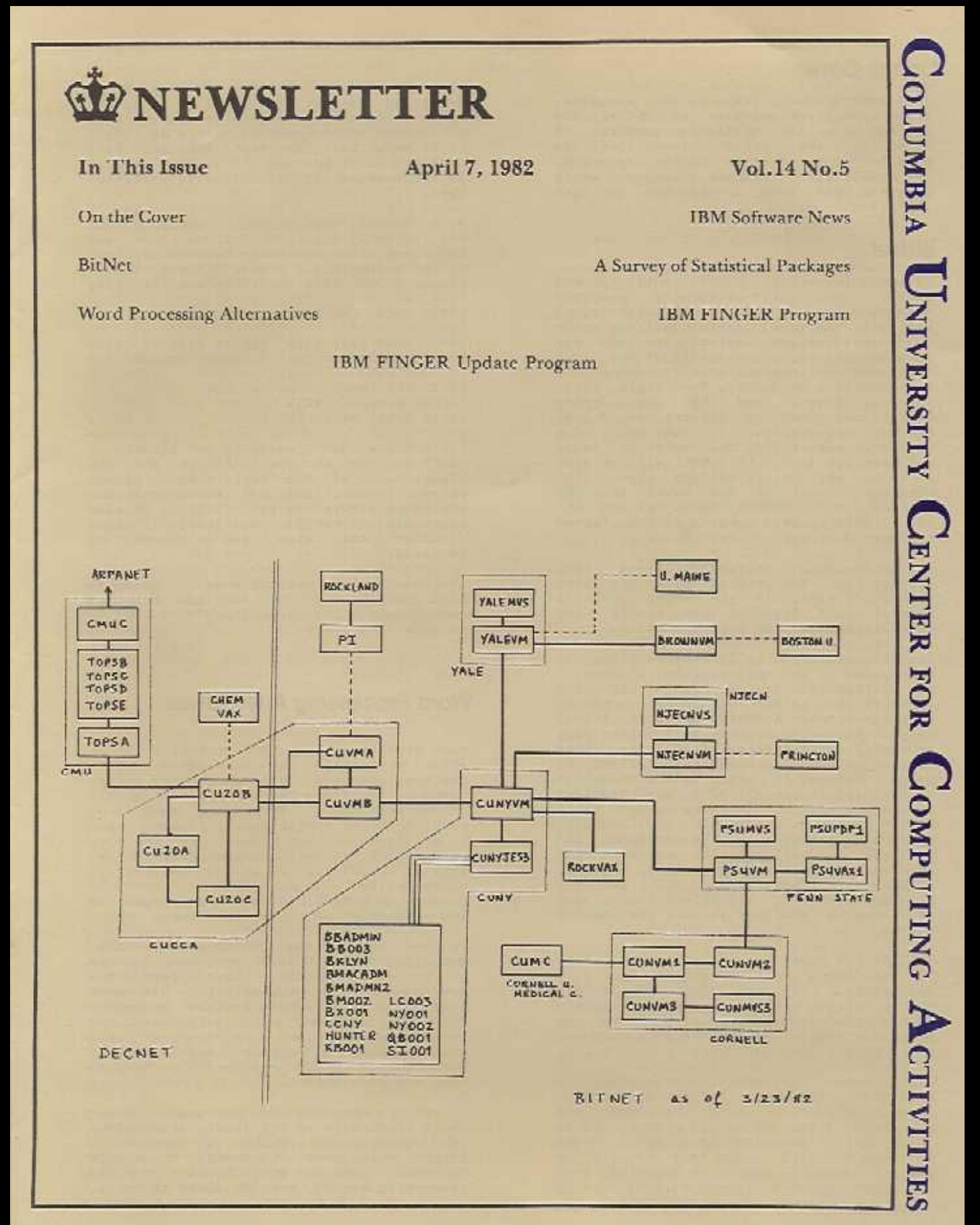


http://en.wikipedia.org/wiki/IBM_3270

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

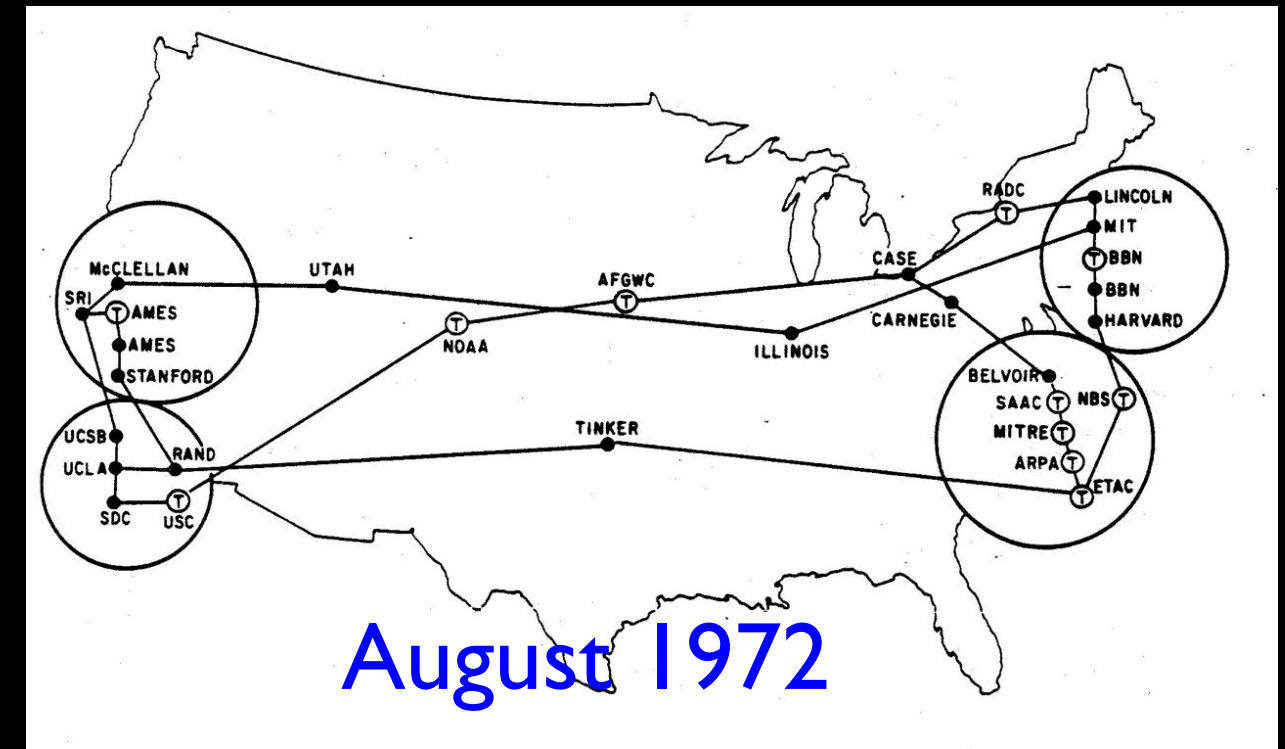
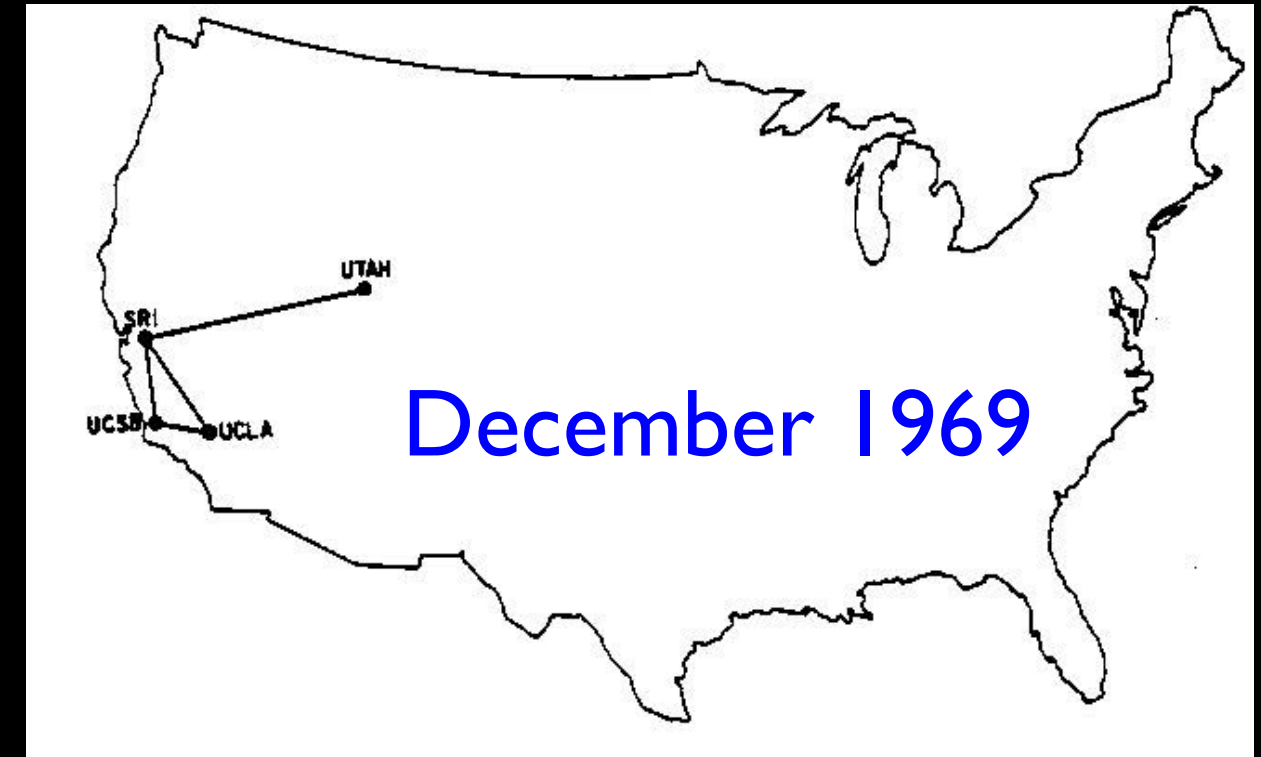
- Academic network in the 1980's
<http://www.columbia.edu/acis/history/bitnet.jpg>



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?



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)



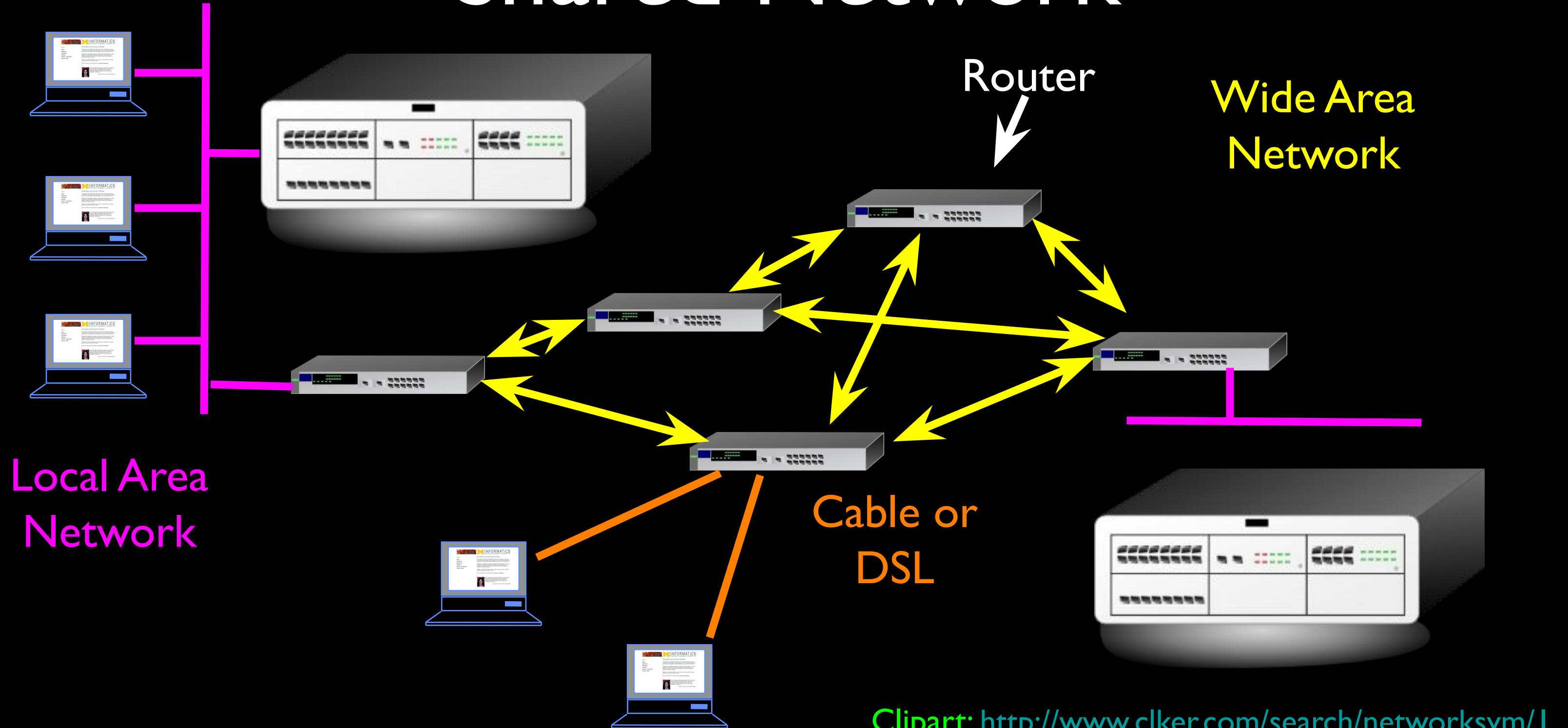
Packet Switching - Postcards



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

Hello there, have a nice day.

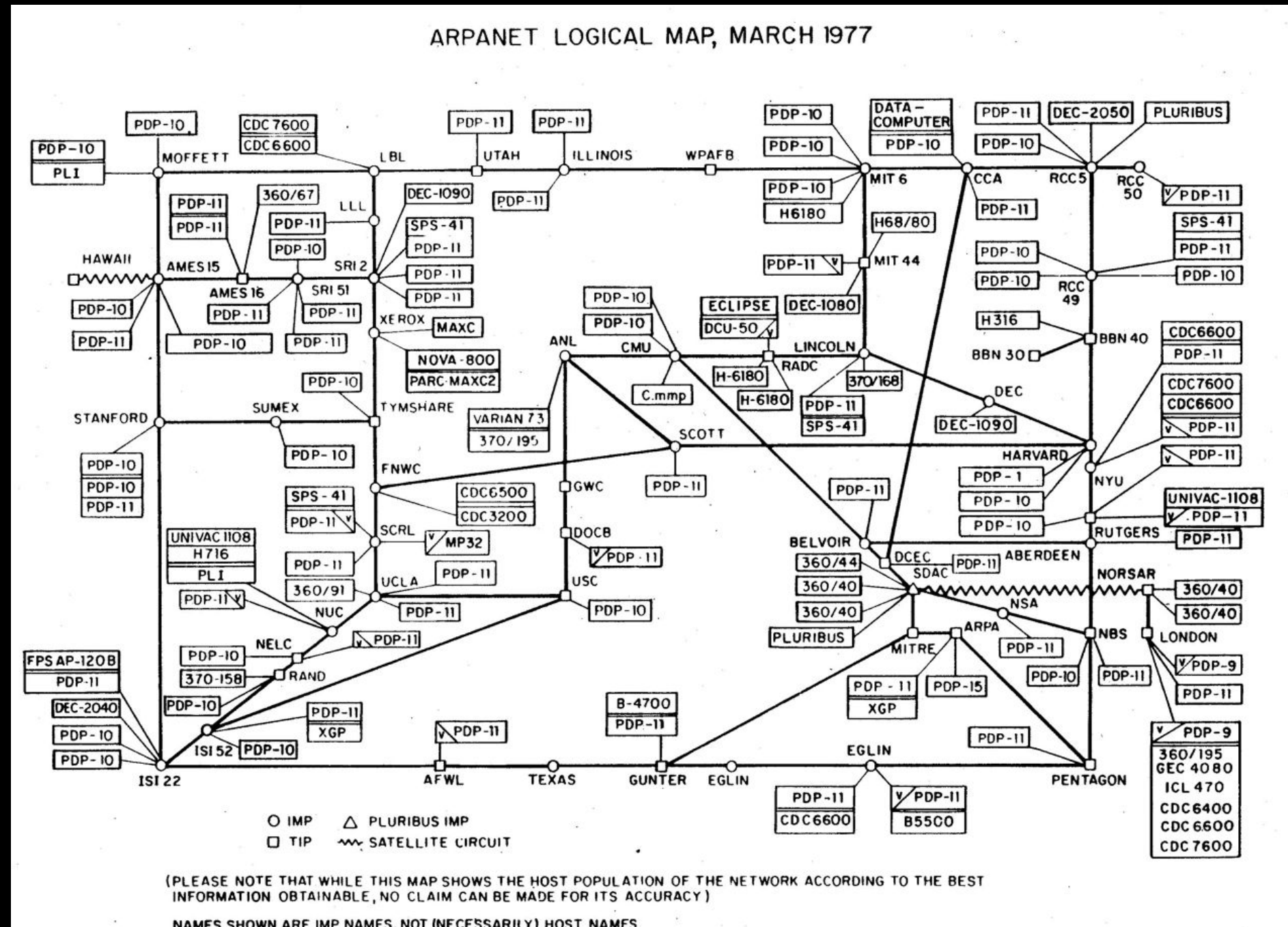
Shared Network



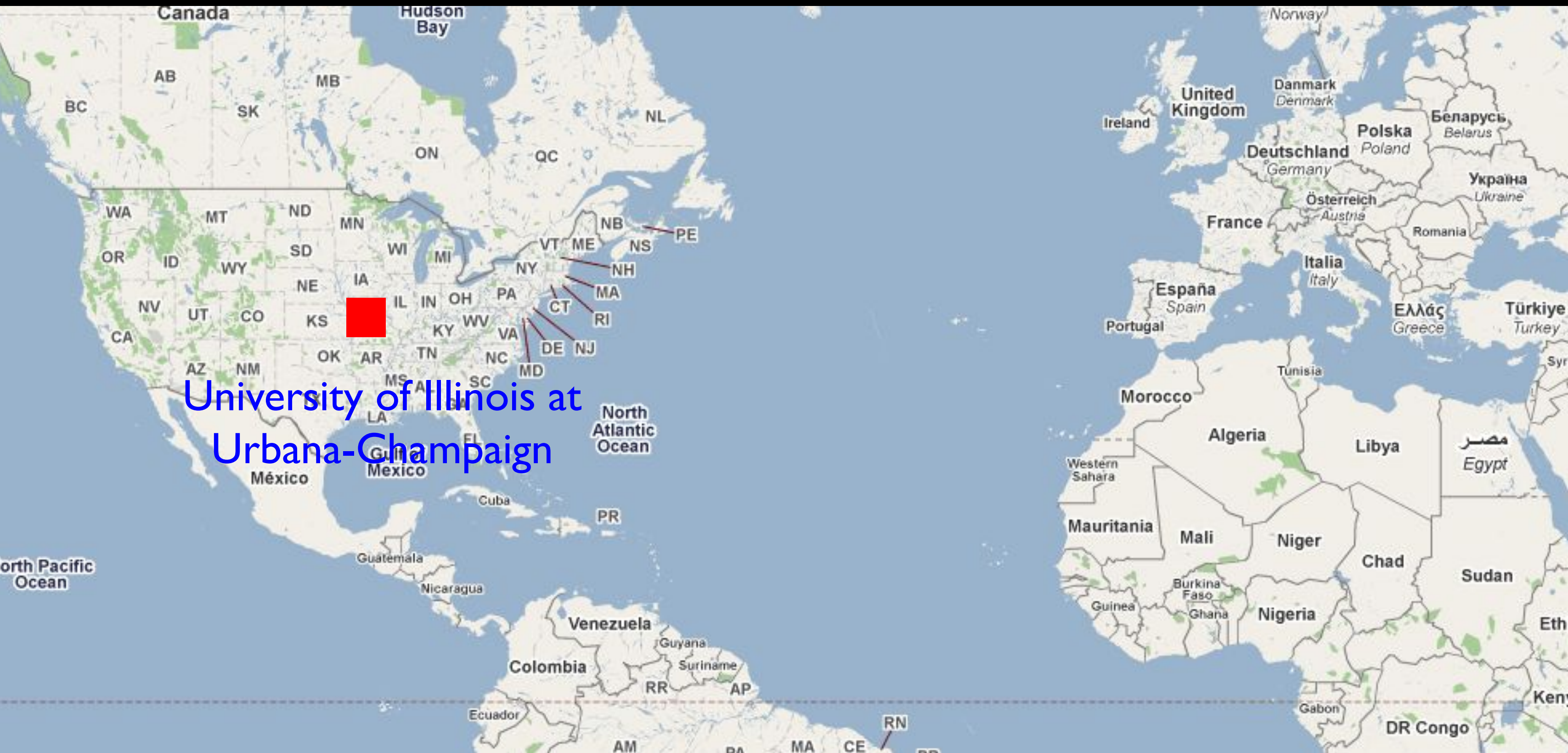
An Example Problem to Solve

- 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"?





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/arpametmar77.jpg>



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?”



CC: BY-SA: Rama ([Wikipedia](https://en.wikipedia.org/wiki/Cray_T3E))
http://creativecommons.org/licenses/by-sa/2.0/fr/deed.en_GB

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

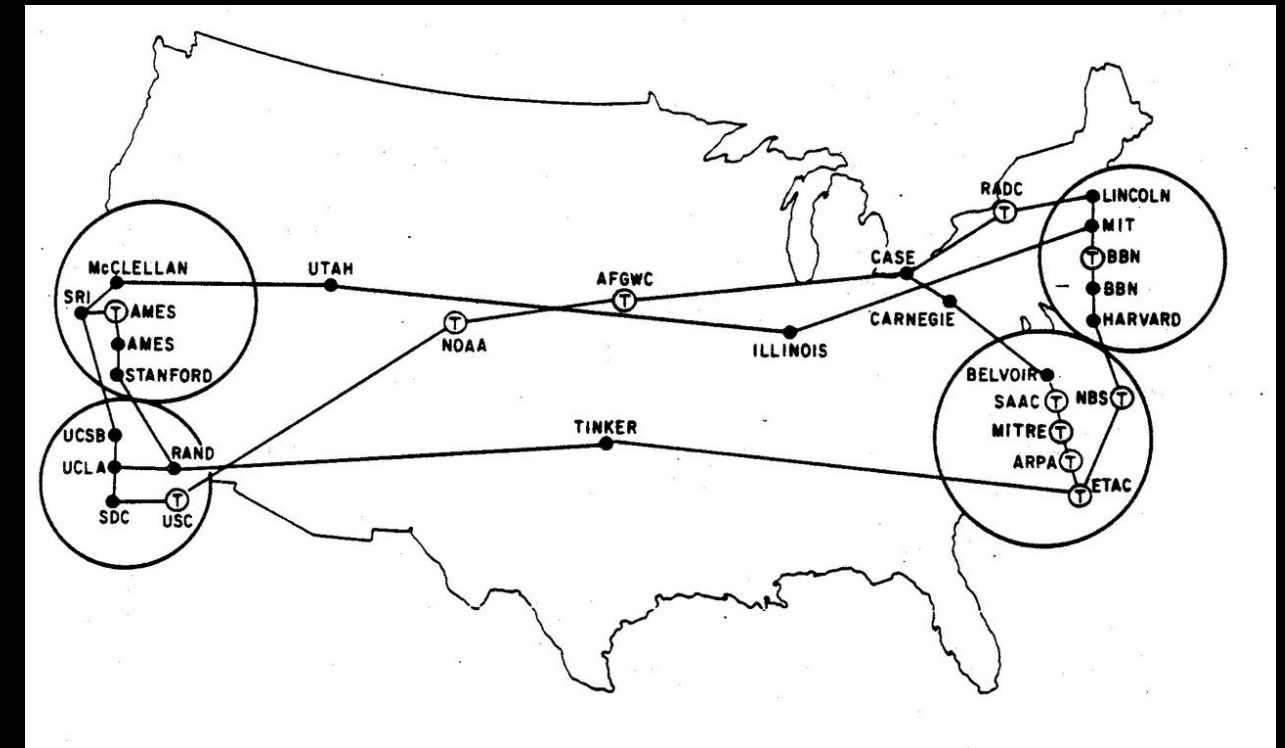


<http://www.vimeo.com/6982439>

(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

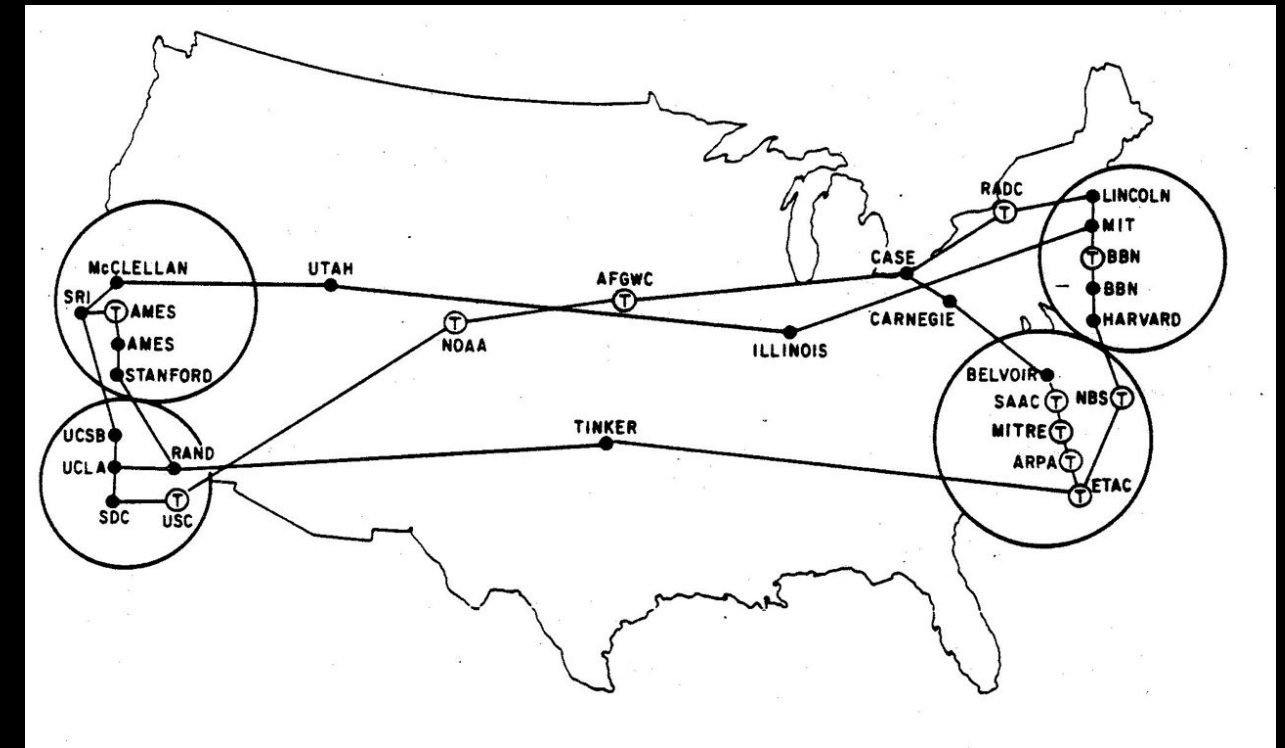


University of Michigan

University of Illinois at
Urbana-Champaign

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

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]

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



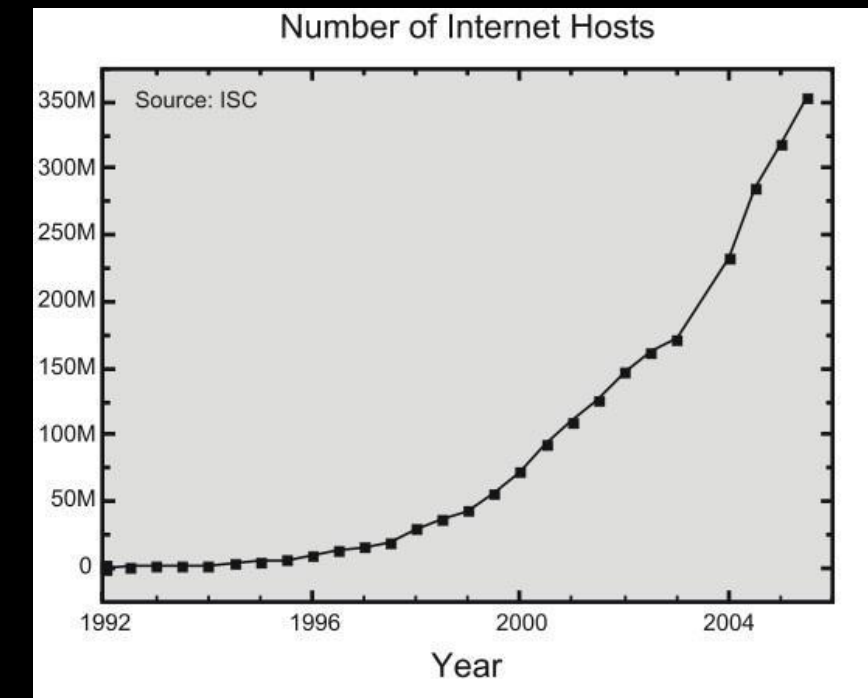
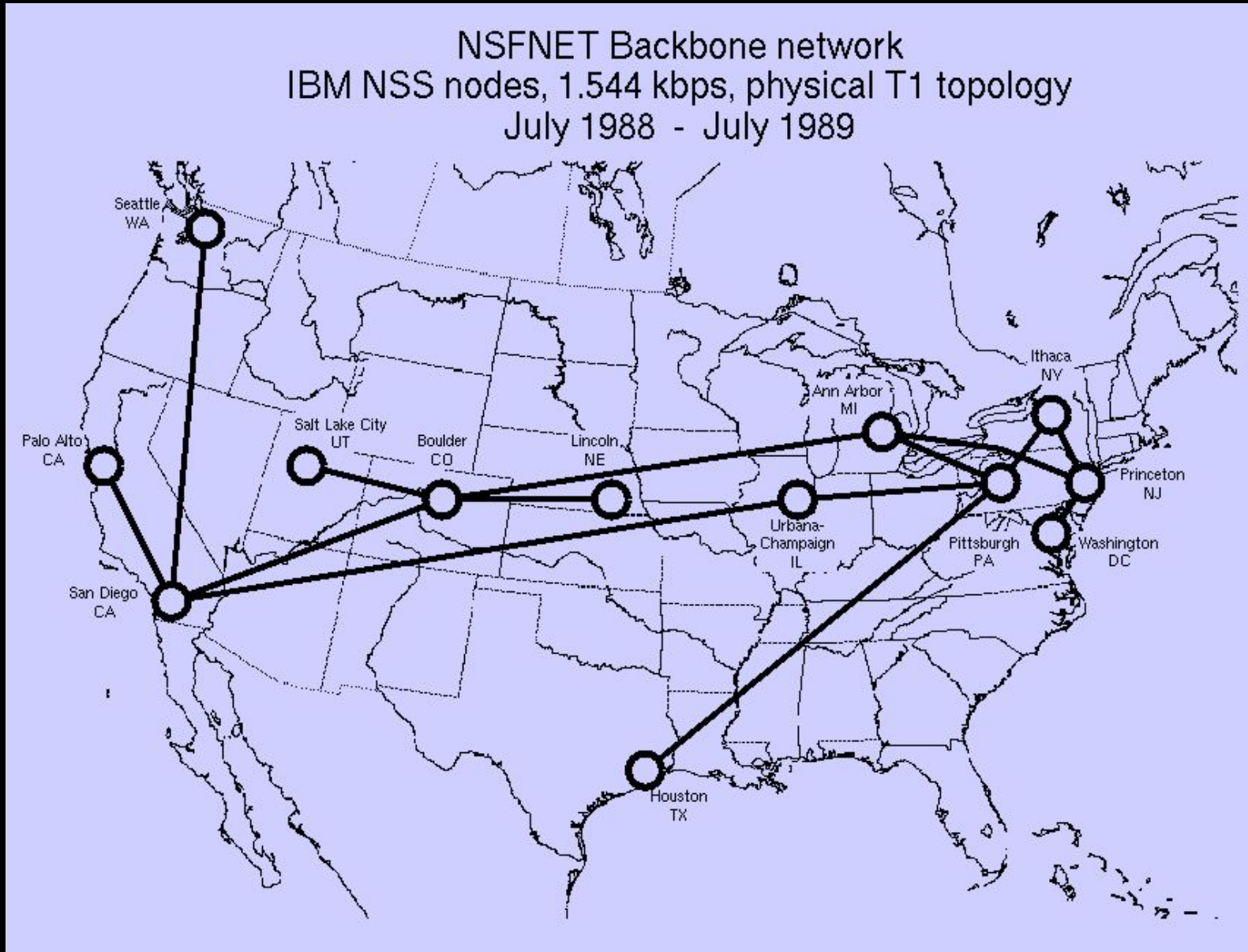
Merit [PDP-11](#) Merit PDP-11
based Primary
Communications Processor
(PCP) at the [University of
Michigan, c. 1975](#)

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

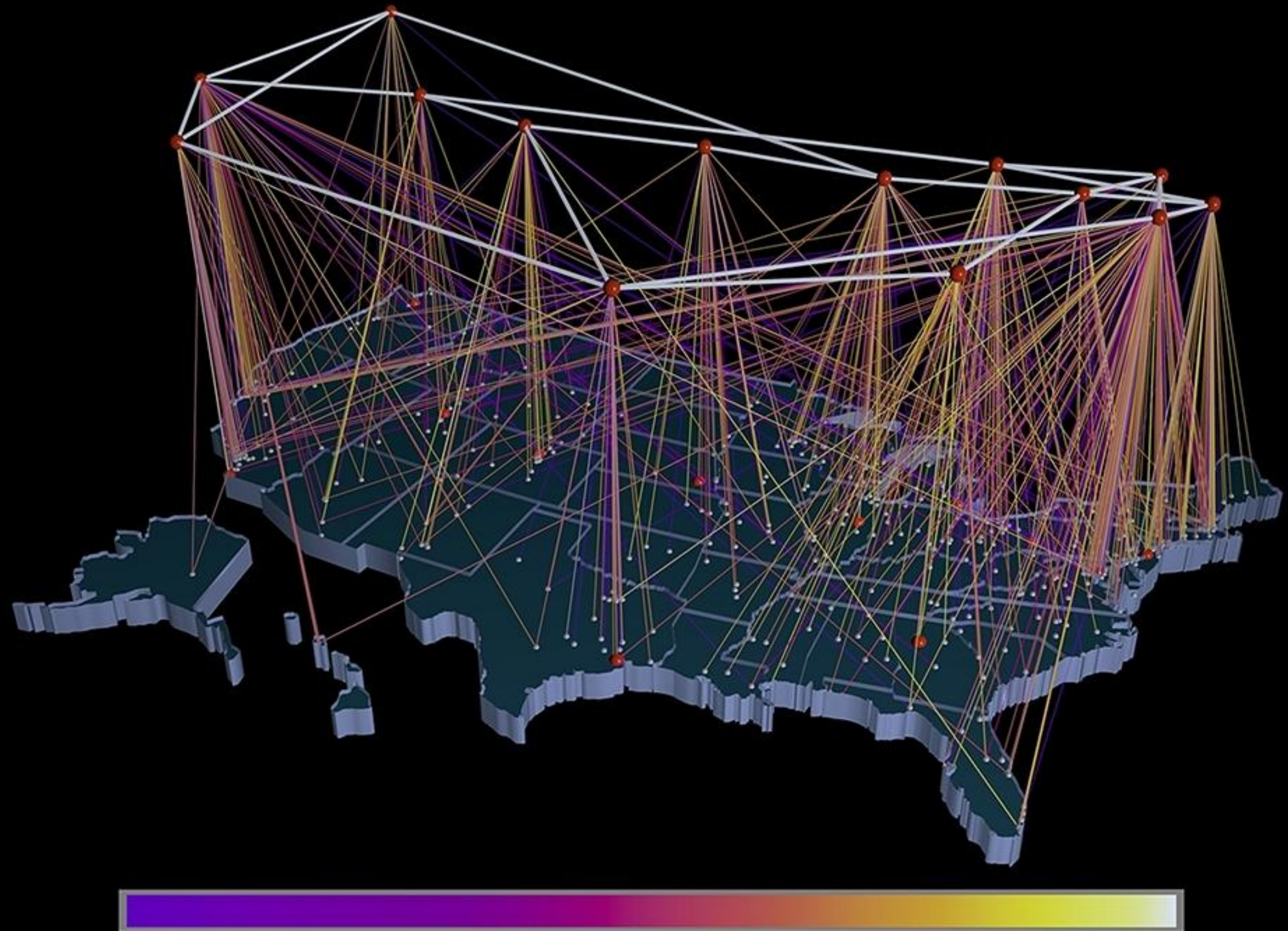


<http://www.vimeo.com/11044819>



Source: <http://hpwren.ucsd.edu/~hwb/NSFNET/NSFNET-2007II/Summary/>

NSFNET I
Backbone and
Regional
Networks, 1991



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



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://musicclub.web.cern.ch/MusiClub/bands/cernettes/>

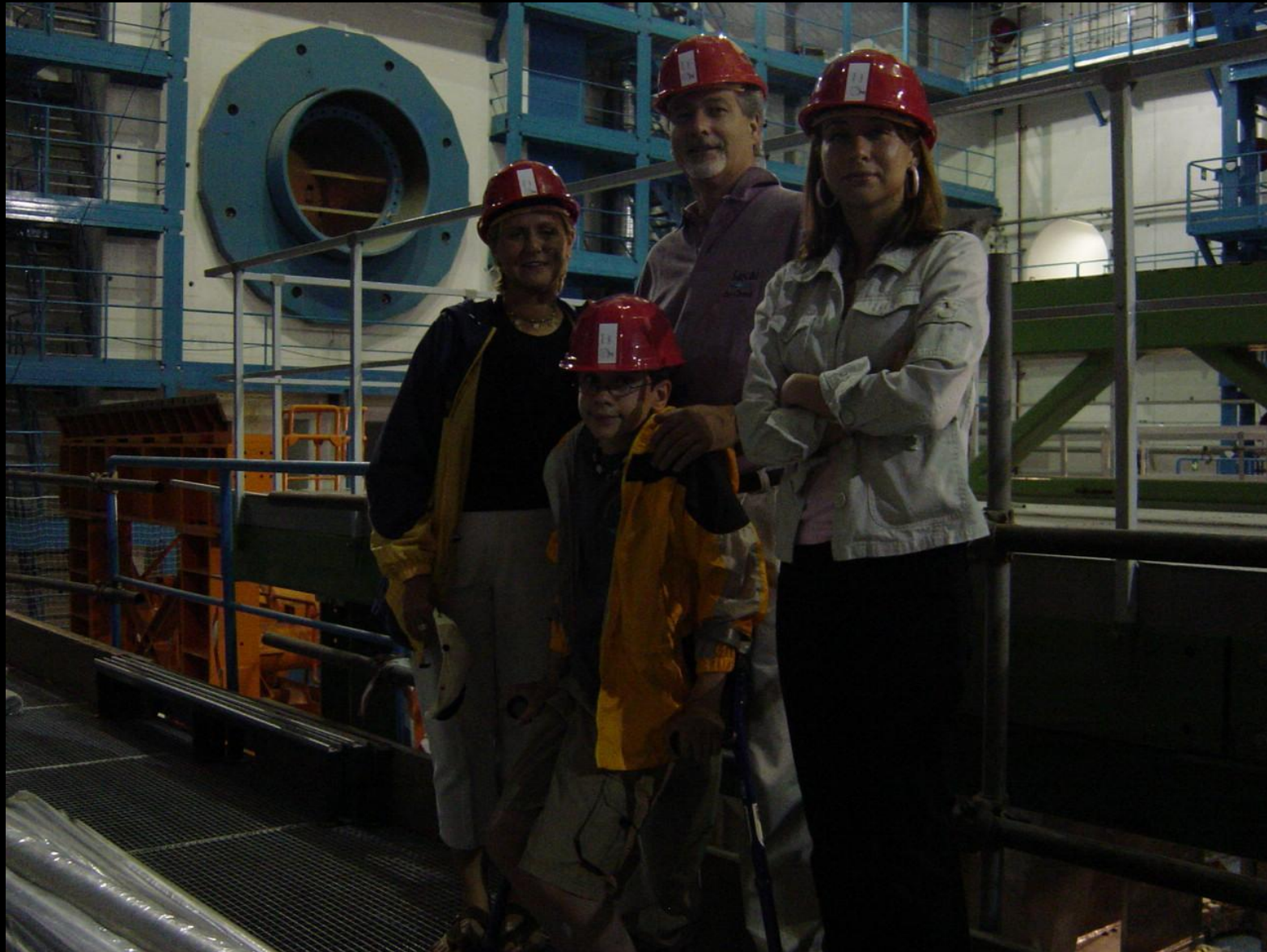
<http://www.youtube.com/watch?v=AIL2xODZSI4>

"...You Prefer your Collider"





Visits to CERN!



<http://club-softball.web.cern.ch/club-softball/Canettes/>
<http://www.youtube.com/watch?v=f90ysF9BenI>



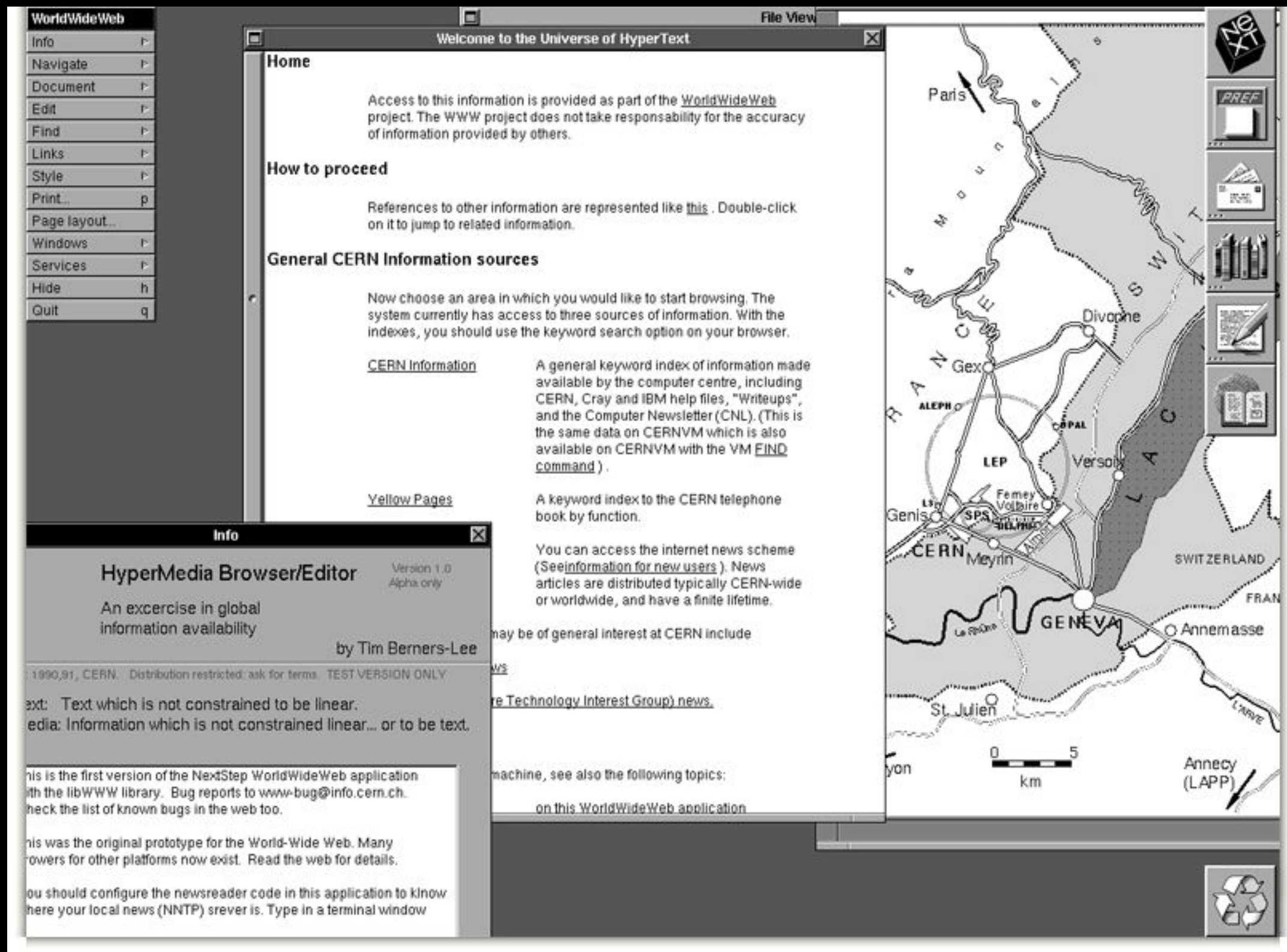
The Beginning of the Web: CERN

- 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=x2GylLq59rl>

(9:42)



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



University of Michigan

Stanford

University of Illinois at
Urbana-Champaign

CERN

The First Web Server in America

- The first web server in America was at the Stanford Linear Accelerator (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

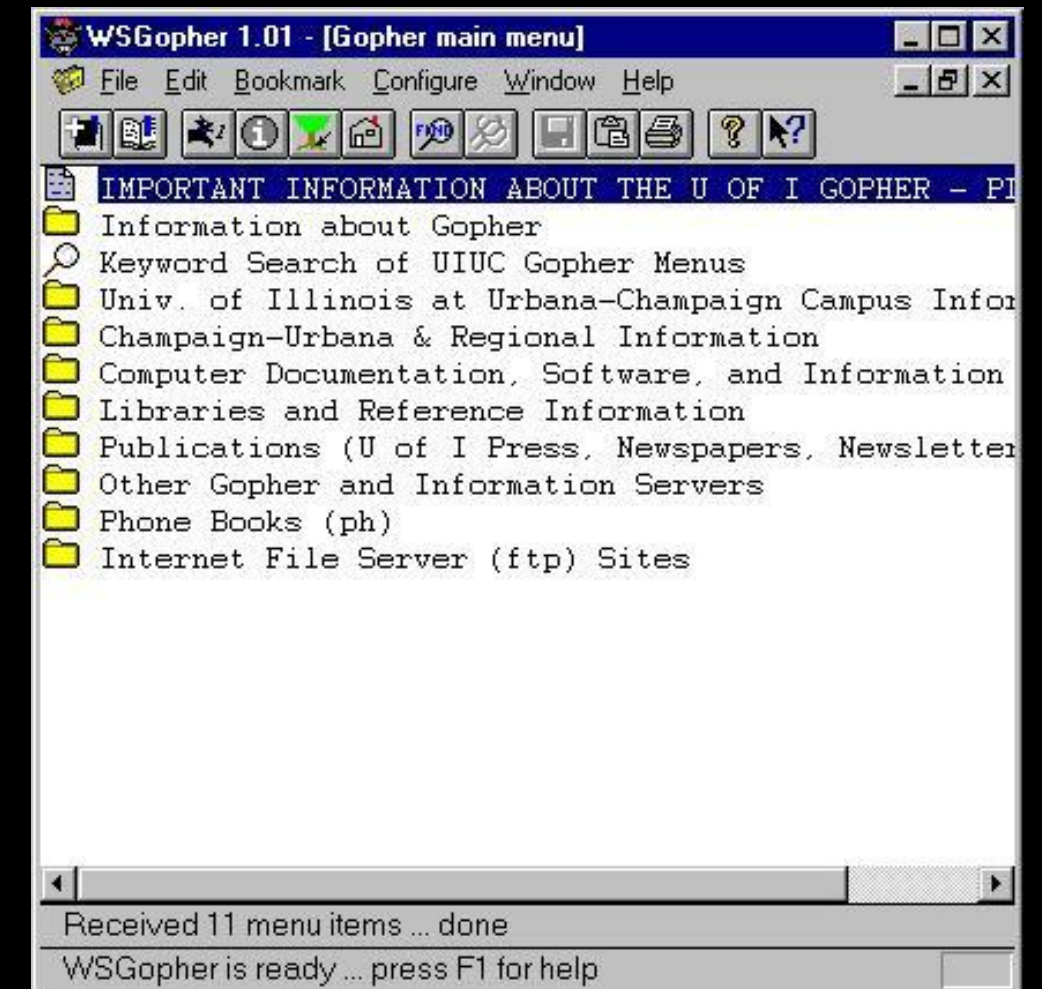
- Internet Engineering Task Force (IETF) Meeting

- March 29-April 2, 1993 - Columbus, Ohio, USA (638 attendees)

- Gopher BOF - 200 attendees

- World-Wide Web BOF - 15 attendees including Tim Berners-Lee

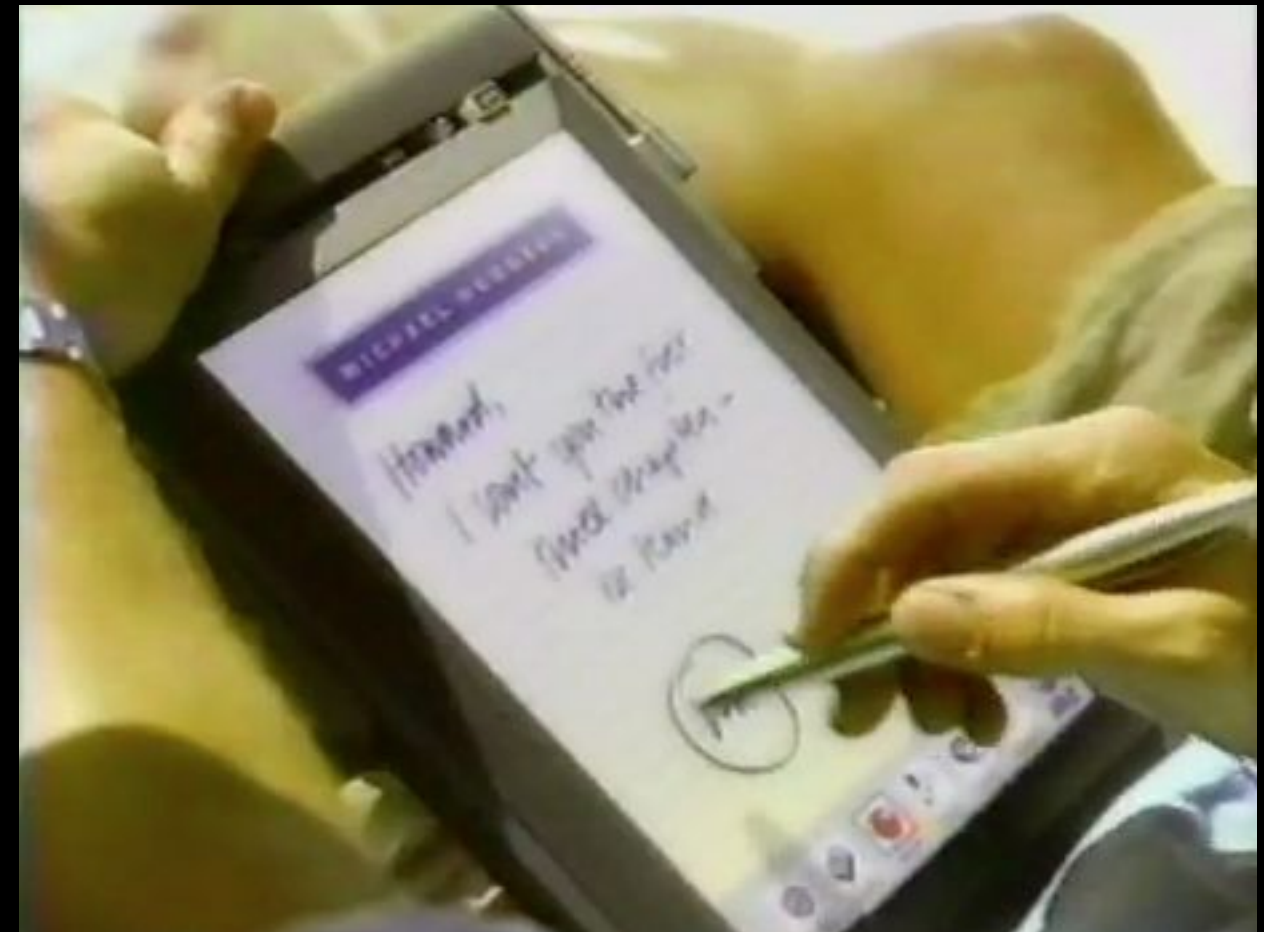
- P.S. DVD is invented this year



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

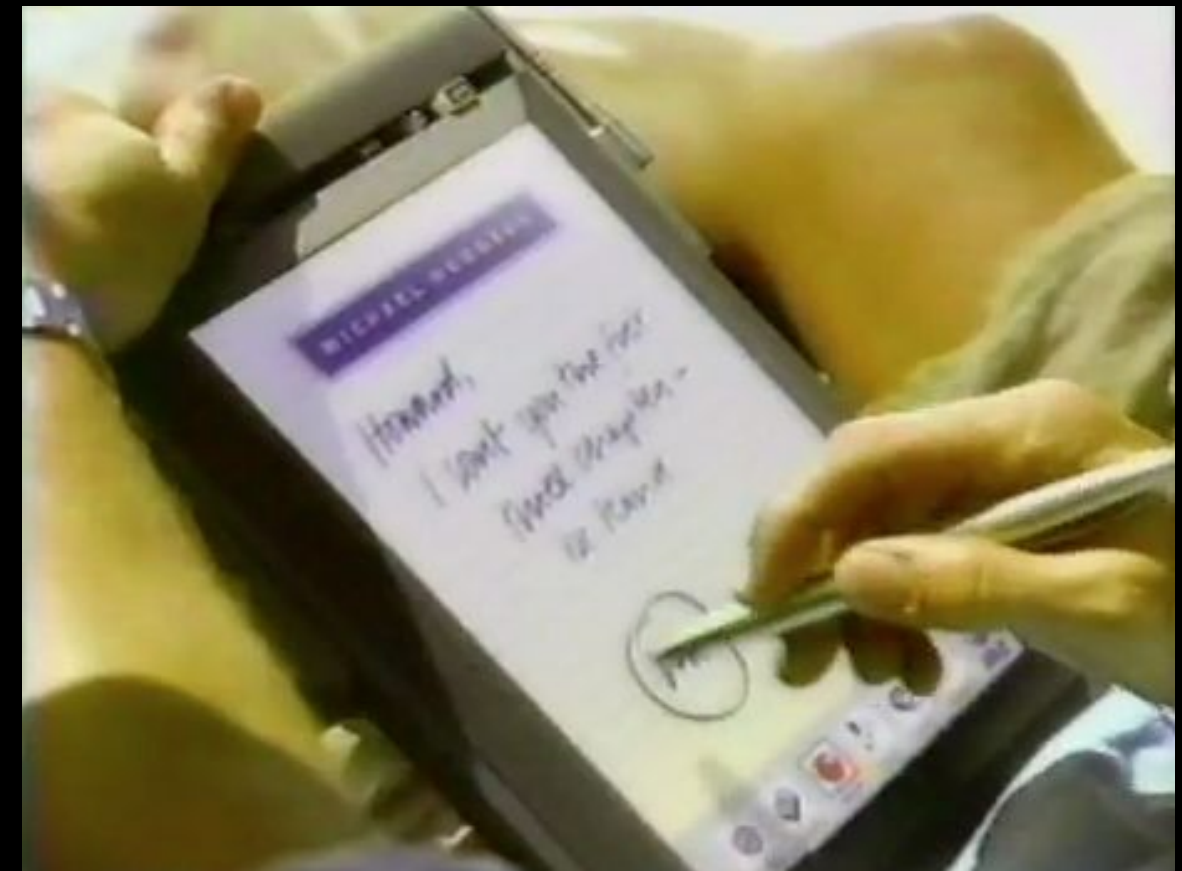


What industry was
thinking in 1993...



<http://www.youtube.com/watch?v=sYNUcFMClzw>

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>





University of Michigan

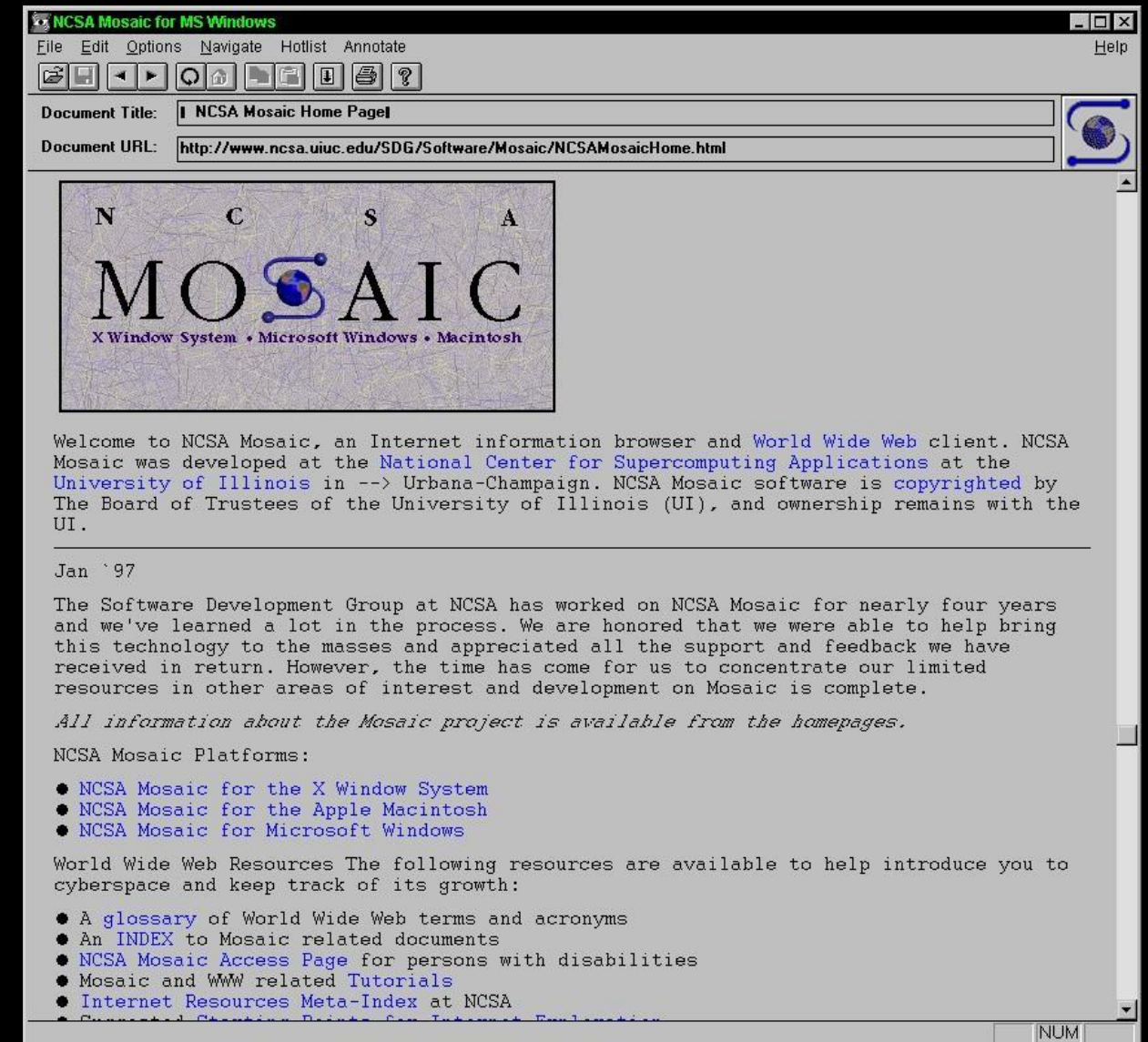
Stanford

University of Illinois at
Urbana-Champaign

CERN

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



Joseph Hardin, UM

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 vengeance!

Netscape, JavaScript and FireFox

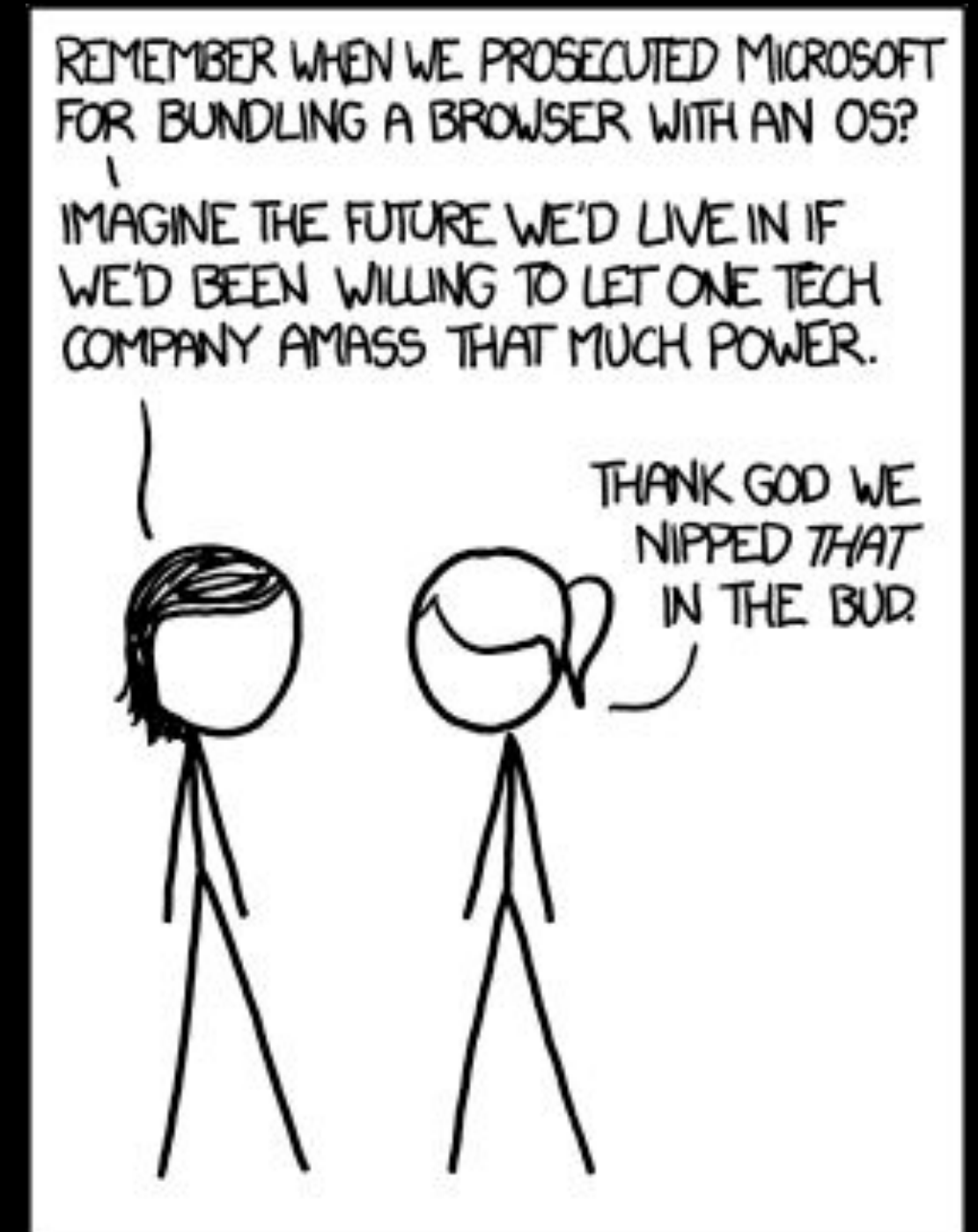
- As Microsoft worked to suffocate Netscape::
- JavaScript was invented to compete with Visual Basic (1995)
- Netscape slowly leaked out into Open Source as Mozilla - which later became FireFox (late 1990's)
- FireFox's search box gave the small Mozilla

<http://www.youtube.com/watch?v=IPxQ9kEaF8c> of revenue



Did Microsoft Save the World-Wide Web?

- Netscape wanted to make the web browser, web server, and web protocols proprietary 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/118/>

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

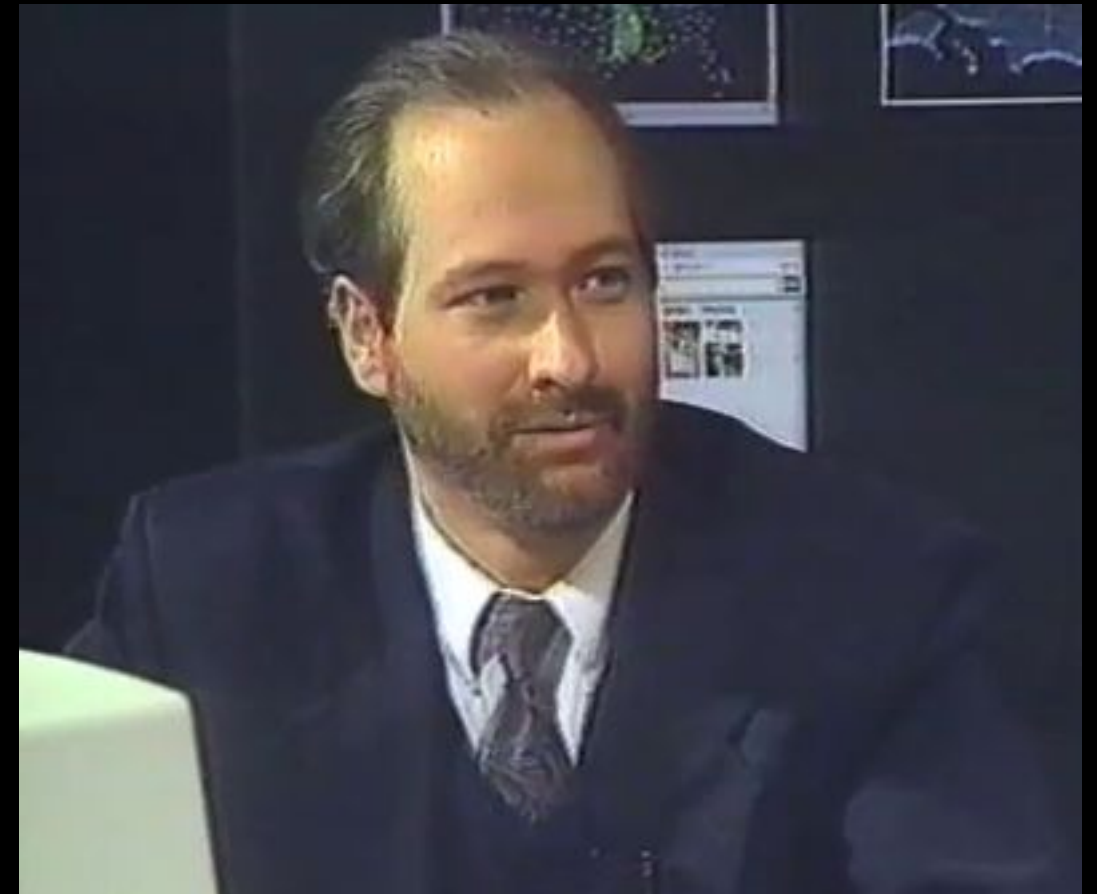
When You Can Assume the Web

Internet: TCI Show 08

<http://www.vimeo.com/4275919>

December 11-14, 1995

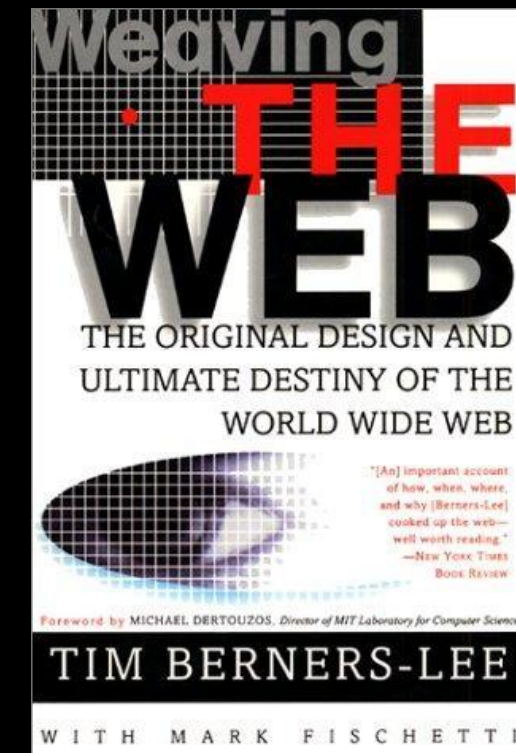
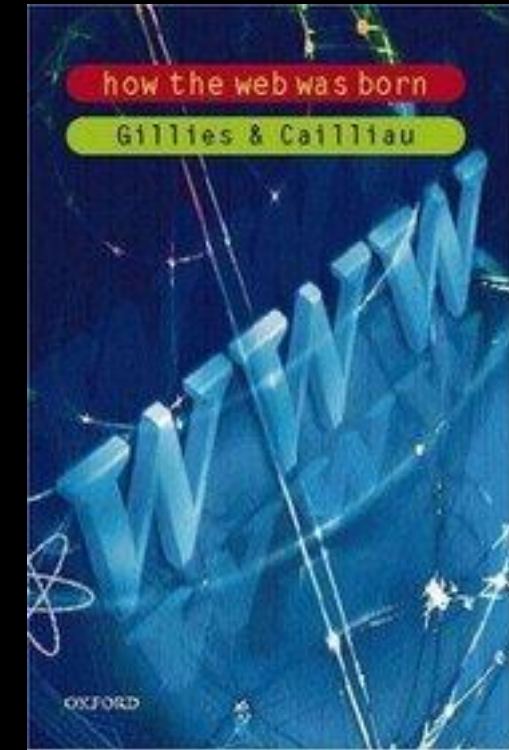
<http://www.w3.org/Conferences/WWW4/>



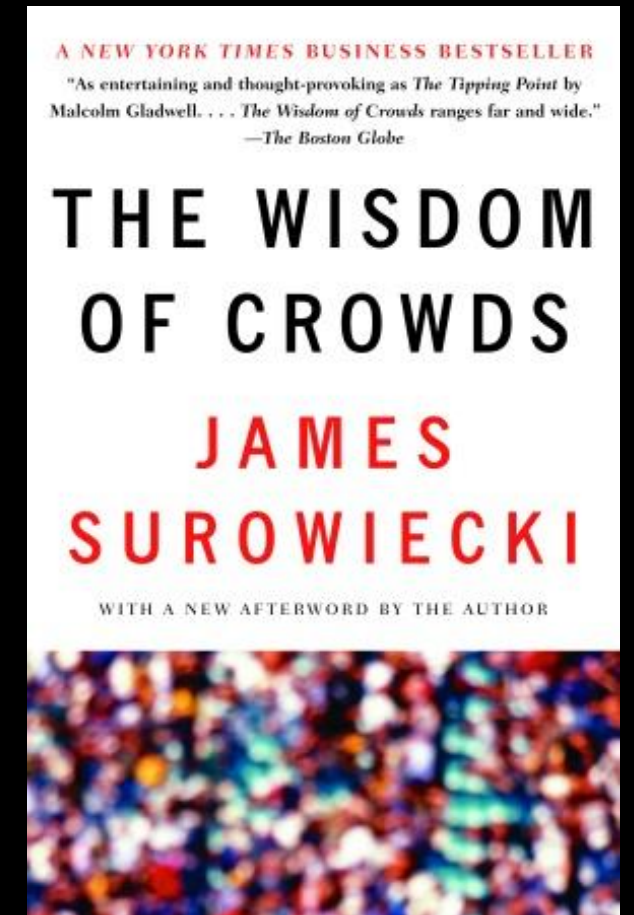
1:22

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
- University 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



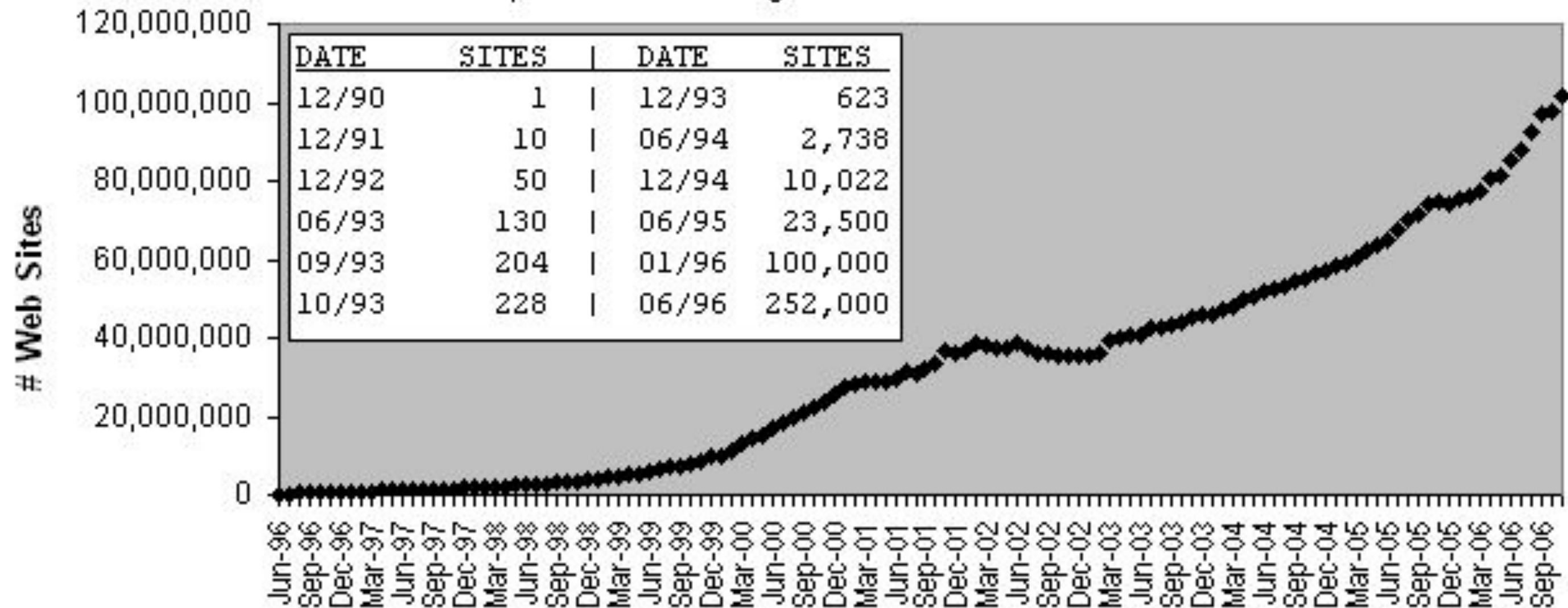
<http://www.vimeo.com/7048422>

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

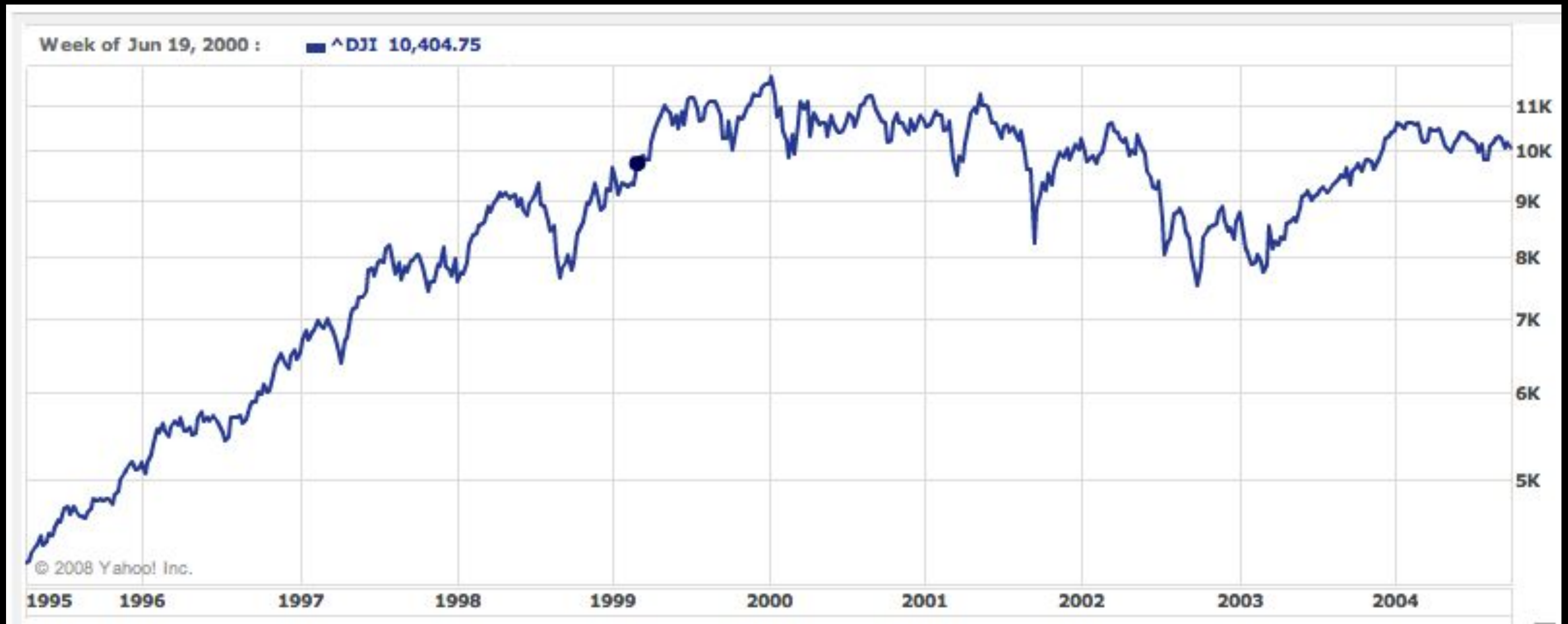
Hobbes' Internet Timeline Copyright ©2006 Robert H Zakon

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



<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>

Additional Source Information

Reuse of these materials

- I intend for these materials to be reusable as open educational resources for those who would do so in a responsible manner
- Please contact me if you are interested in reusing or remixing these materials in your own teaching or educational context