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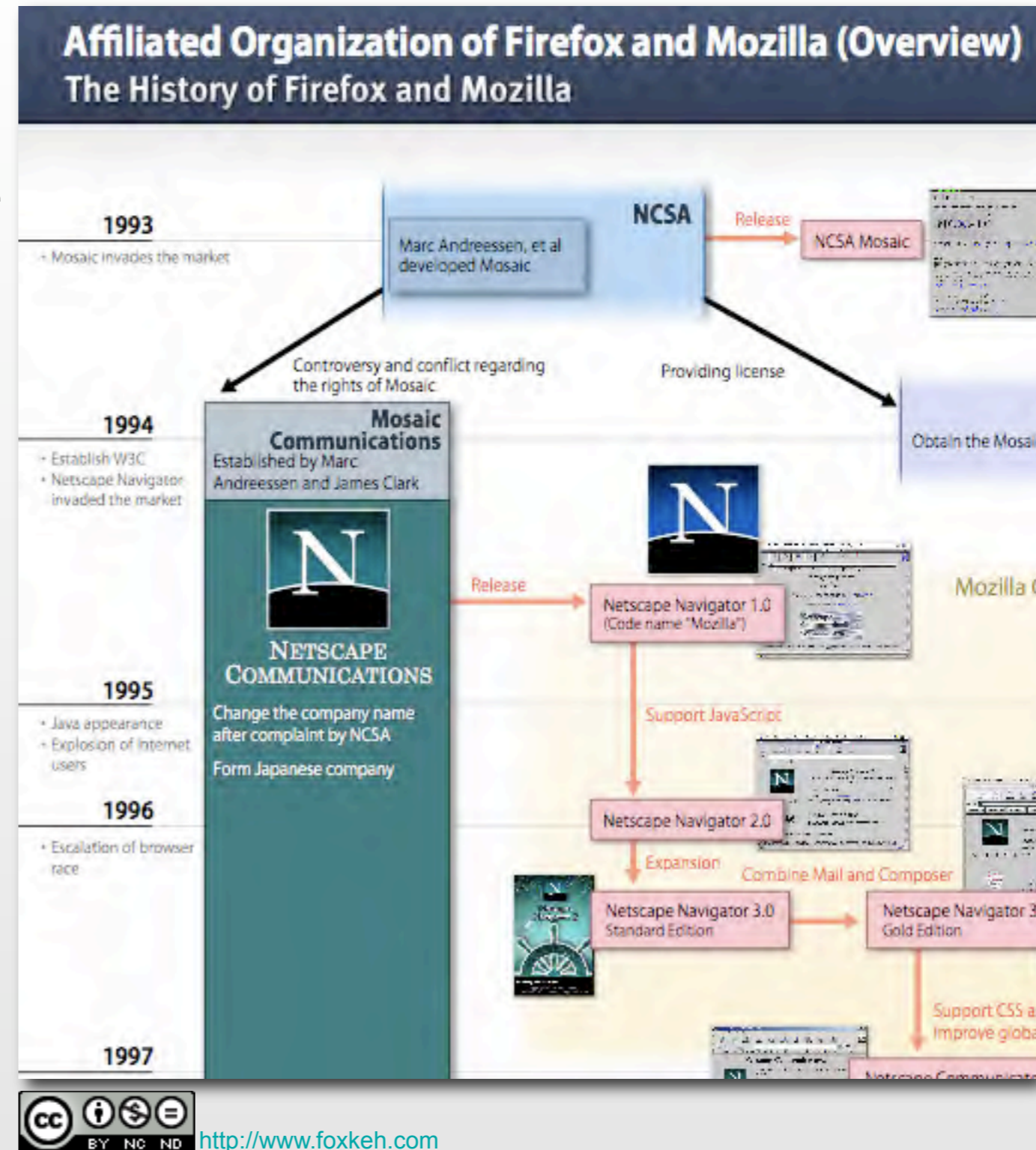
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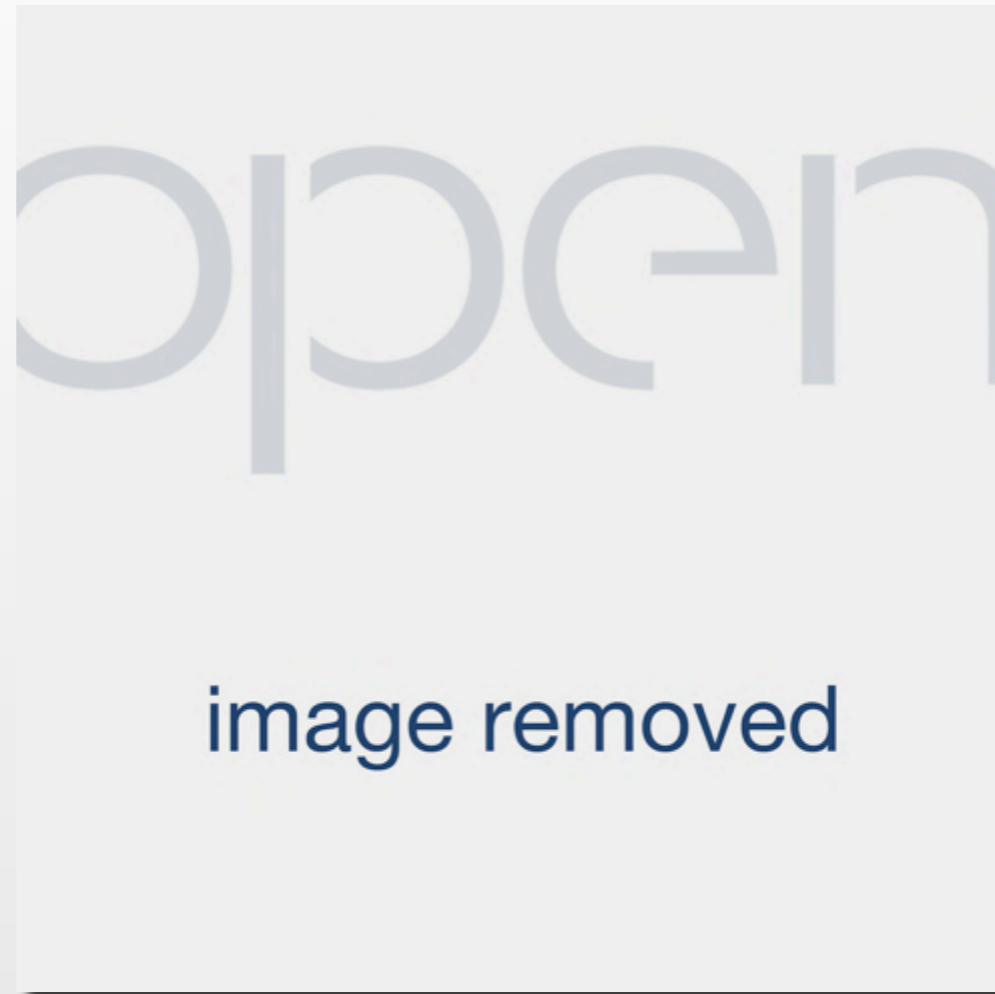
Cyberscience: Computational Science and the Rise of the Fourth Paradigm

Honors 352, Class #0.12
August E. (Gus) Evrard, PhD

Fall 2010



in memory of Alex Anderson



Please see obituary and photograph of Alex Anderson at
http://www.nytimes.com/2010/10/26/arts/television/26anderson.html?_r=1&ref=obituaries.

today

- * lecture: early networks, the internet and birth of the World Wide Web
- * in-class exercise: read+discuss *The Standards Industry*
- * reading for Thursday: Future of Supercomputing, Ch 5, 6, 7
- * no reading quiz this week
- * midterm paper (1500-2000 words) due THURSDAY

cold war genesis

- * early 1960's: US (P. Baran) + Britain (D. Davies) develop **packet switching** as method to maintain military command and control during nuclear war
- * 1964: movie *Dr. Strangelove* describes fictitious **Plan R**

Plan R is an emergency war plan in which a lower-echelon commander may order nuclear retaliation after a sneak attack – *if* the normal chain of command had been disrupted. ... The idea was to discourage the Russkies from any hope that they could knock out Washington ... as part of a general sneak attack and escape retaliation because of lack of proper command and control.

ARPANET concept

* 1962: Advanced Research Projects Agency (ARPA) founds Information Processing Techniques Office (IPTO)

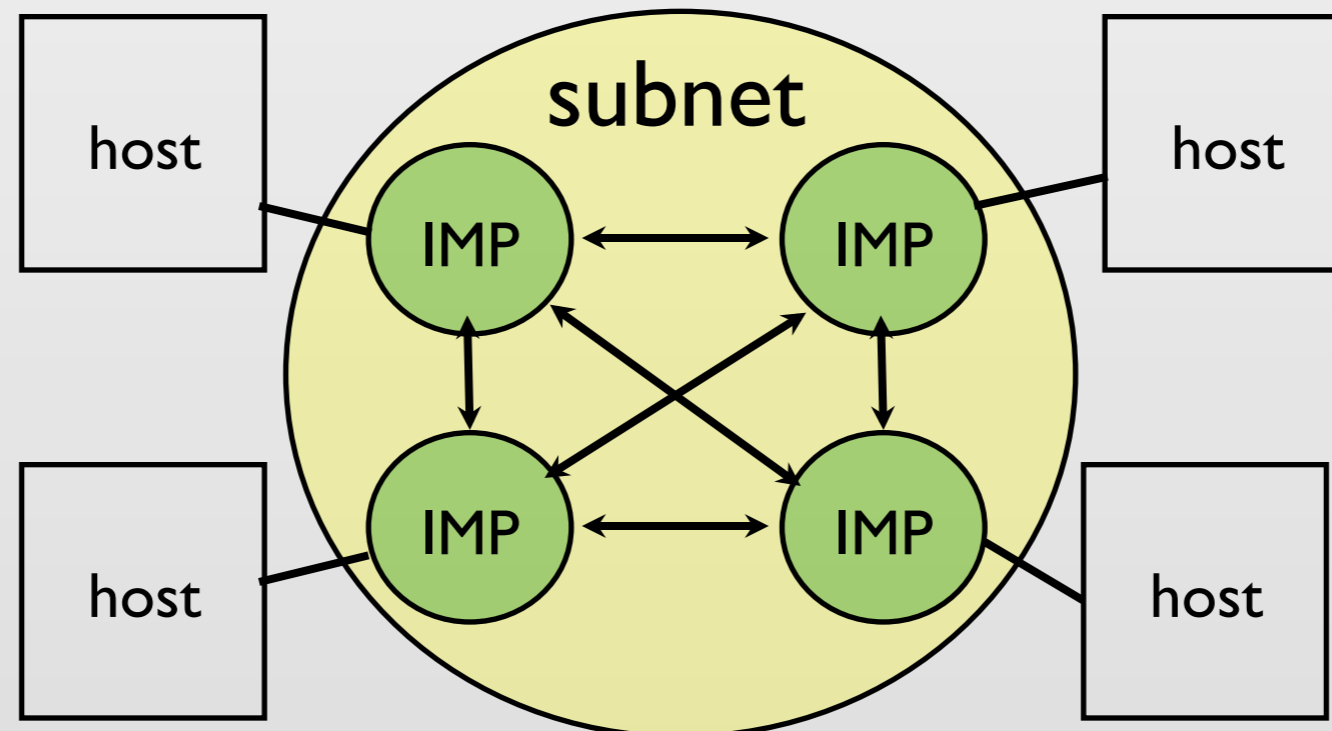
– IPTO grants build field of **computer science**

* 1967: Lawrence Roberts (MIT) leads network project

challenge = connect machines from IBM, DEC, GE, UNIVAC +...

– learns of packet switching concept

– Wesley Clark (Wash. U) suggests **layering**; use microcomputers to build a **subnet** of **Interface Message Processors (IMP's)**

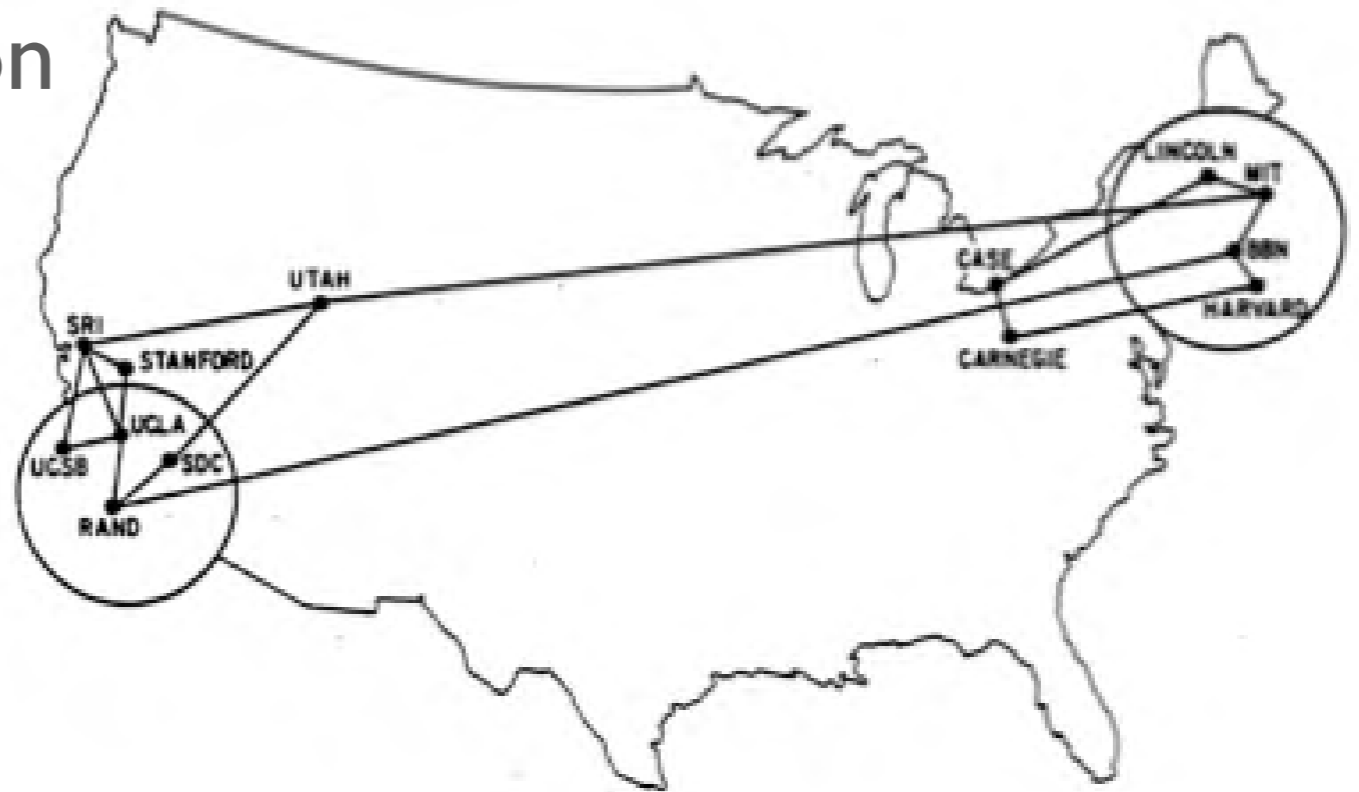


ARPANET as utility computing

- * resource sharing provided additional motivation from first published description

Currently, each computer center in the country is forced to recreate all of the software and data files it wishes to utilize. In many cases this involves complete reprogramming of software or reformatting the data files. This duplication is extremely costly. ... With a successful network, the core problem of sharing resources would be severely reduced.

© FAIR USE Lawrence Roberts and Barry Wessler, 1970, pg. 543.



© PD-INEL <http://som.csudh.edu/fac/lpress/history/arpamaps/f7dec1970.jpg>

- * e-mail originally “not an important motivation for a network of scientific computers” (Roberts, 1967, p.1)
original focus on connecting **computers**, not **people**

early packet networks

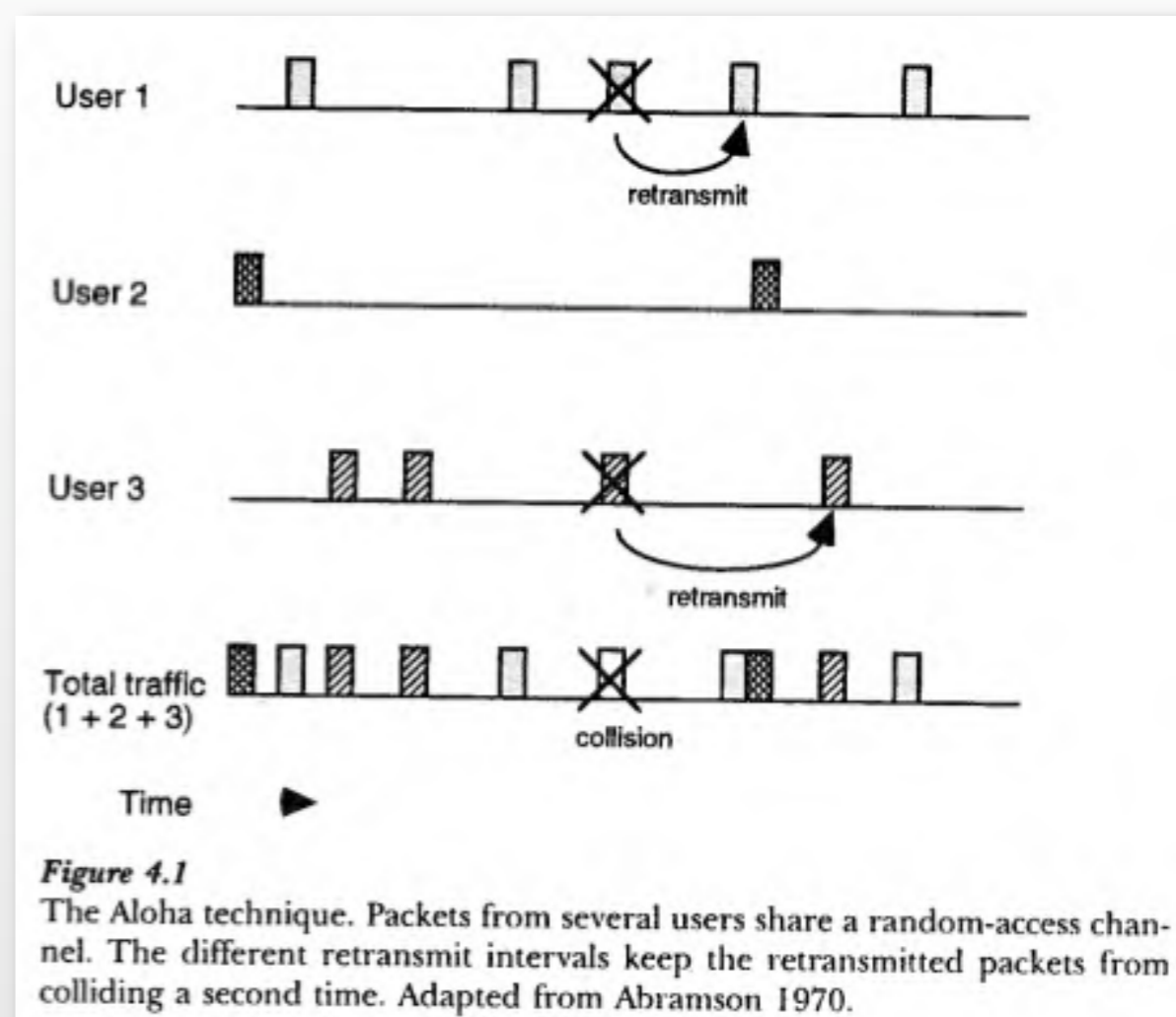
* 1970: Alohanet in Hawaii uses radio transmission

– retransmit packet (with random delay)
if acknowledgement failed

* 1973: Robert Metcalfe publishes thesis

Packet Communication

key insight - scale retransmit
time interval with network
traffic load



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* 1972: Xerox PARC “Alto Aloha” is renamed **ethernet**

* 1974: Cerf and Kahn publish paper describing **internet** architecture

* 1977: PRNET demonstration in Bay Area (R. Kahn)

first international test

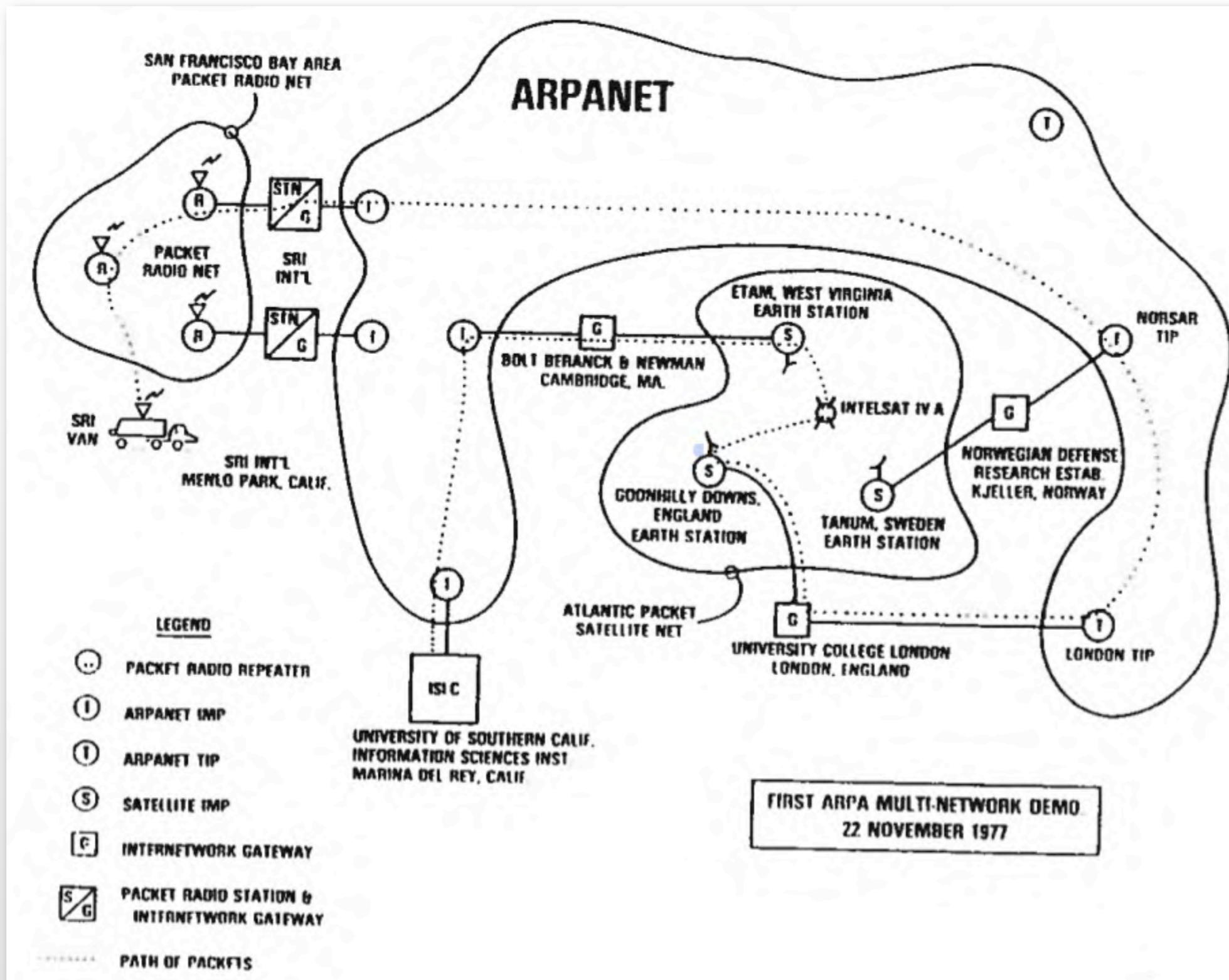


Figure 4.3
Diagram of 1977 Internet demonstration.

TCP/IP

* TCP = Transmission Control Protocol

- open protocol for packet transmission
- verifies safe arrival via acknowledgements
- PUP model: host computers ARE the internet (strong host protocols)
(PUP = PARC Universal Packet)
- highly **scaleable** since it enables a hierarchical internet structure
- avoids translating **all** packet traffic between different networks

* IP = Internet Protocol

- open protocol for packet negotiation across/between networks
- function of gateway computers linking different networks

Having to translate between different protocols would have emphasized the boundaries between networks, and the Internet's designers wanted the system to appear seamless. Indeed, they were so successful that today's Internet users probably do not even realize that their messages traverse more than one network.

standards emerge (slowly)

- * mid-1970' s: computer manufacturers design proprietary protocols

- heavy license fees help profit
- computers still more important than network

- * multiple governing bodies

- ANSI (American National Standards Institute)
- ISO (International Organization for Standardization)
- CCITT (Consultative Committee on International Telegraphy and Telephony)

...

- * open/academic vs. proprietary/industrial struggle as Internet goes public

The result was a Babel of competing and incompatible “standards”.

the Internet just wants to be free...

Charging users for network services had never been a priority for ARPA. One ARPA contractor, Franklin Kuo, explained in 1975: “During the early days of the ARPANET, ARPA paid the entire communications and computation bill. ... At the time of this writing, no network-wide accounting plan has yet been instituted.” (Kuo 1975, pp. 3-15) TCP/IP had not been designed for a network serving as a public utility, with service guarantees and access charges; X.25 had been.

layered structure of the OSI standard

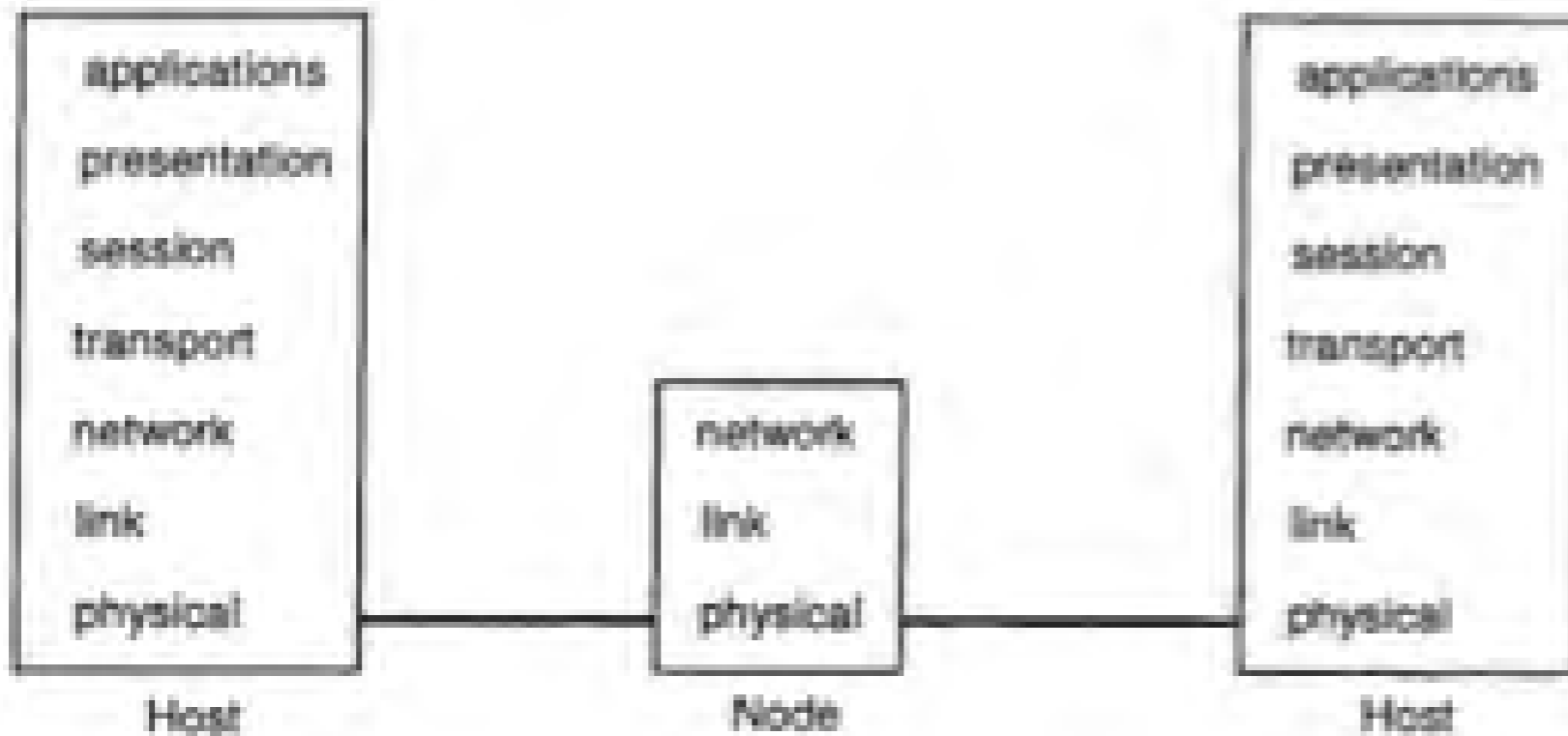


Figure 3-5
The OSI model, showing protocol layers for hosts and nodes.

physical: hardware
link: bit stream
network: packet structure

modern internet

- * 1983: MILNET separates from ARPANET
- * mid-1980's: local area networks (LANs) proliferate
 - from 15 in 1982 to >400 in 1986
- * Domain Name Service (DNS)
 - hierarchical structure of networks and subnets
 - high level domains: .edu, .mil, .gov, .com, .net, .org
 - both numeric (141.211.96.43) and alphabetical names, translated by host tables
 - umich.edu is born!
- * Today: DHCP (Dynamic Host Configuration Protocol)
 - serves IP (subnet) addresses to clients on demand
 - removes need for large host tables

NSFNET build-out of late 1980's

- * 1984: NSF creates Office of Advanced Scientific Computing

- * 1987: 5-year contract to MERIT

Michigan Education Research
Information Triad

- * 1990: ARPANET is retired

- * 1994: ISP's (Internet Service Providers)

- privatization of service
- gateways link different operators
- vast expansion potential

- * 1980's: growth of the first 'social networks'

- e.g., Whole Earth 'Electronic Link

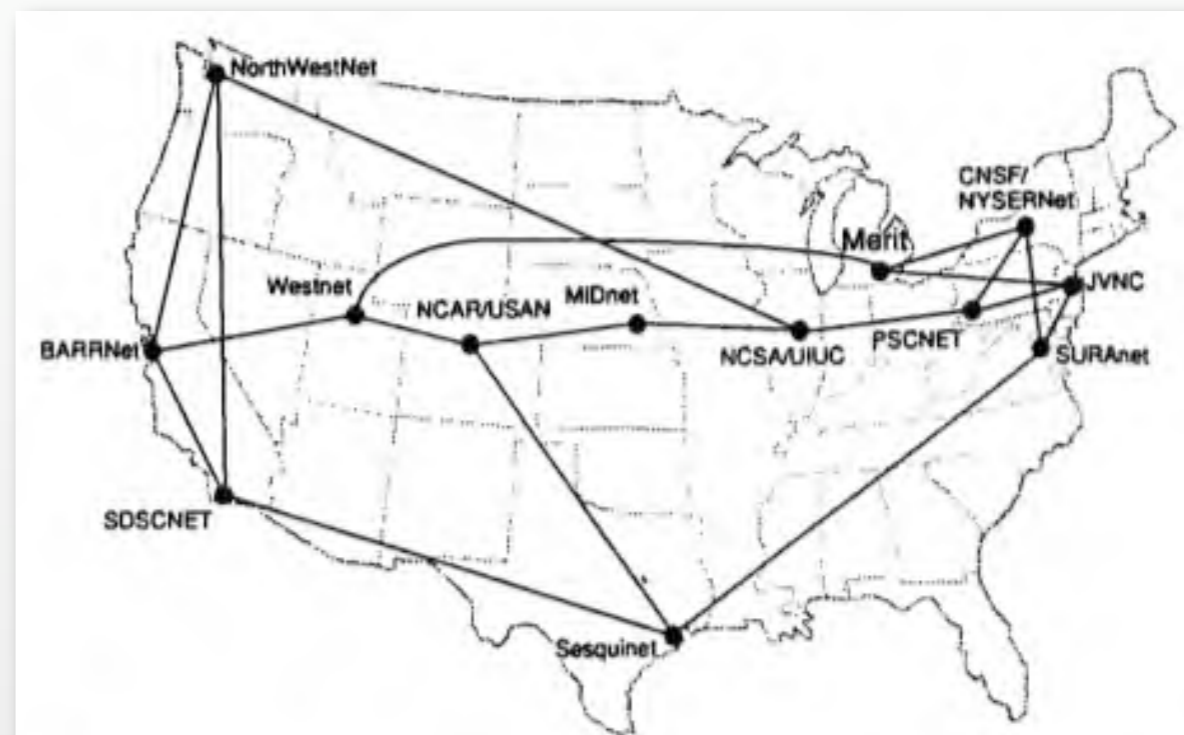


Figure 6.1

The NSFNET in 1989. Source: MERIT 1989. The supercomputer networks were JVNCNet at Princeton, NCSAnet at the National Center for Supercomputing Applications at the University of Illinois, PCSnet at the Pittsburgh Supercomputer Center, and SDSCnet at the San Diego Supercomputer Center.

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Tim Berners-Lee + World-Wide Web

- * file sharing among networked computers via command line not ideal
- * CERN: large collaboration with huge document-sharing requirements
 - visual interfaces becoming dominant over command line
 - **HTML: HyperText Markup Language** built atop TCP/IP
 - demo' d in 1990, released in 1992
- * **1993: NCSA launches Mosaic web browser**
 - 40,000 copies downloaded in first month

the end of civilization as we knew it

* 1997: ***The Goddamn George Liquor Program*** is the first cartoon produced for the internet

Characters in the George Liquor universe

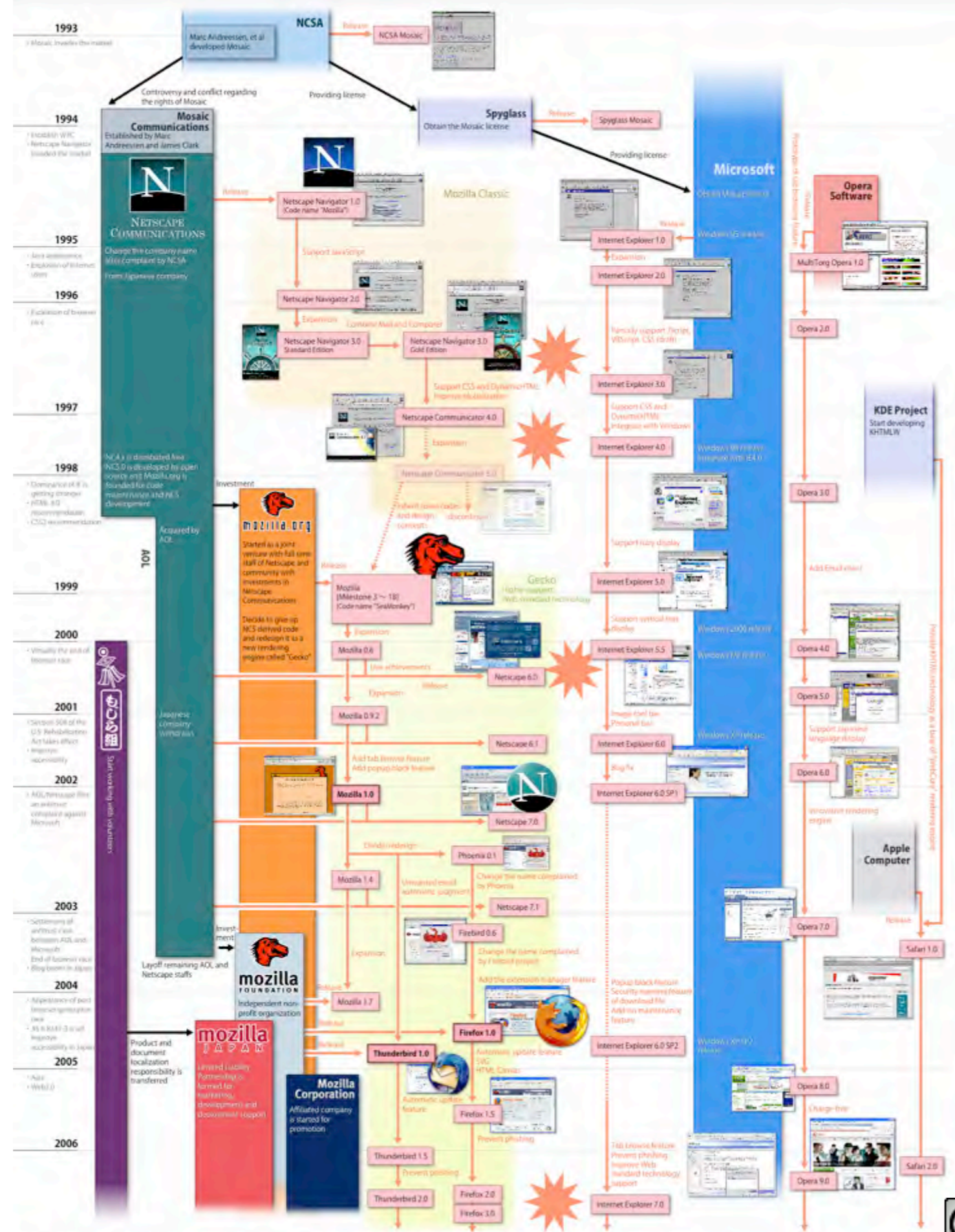
The following characters in the George Liquor universe appear in *The Goddamn George Liquor Program*.^{[7][8]}

- **George Liquor, American** - Liquor is an ultra-patriotic American.



- **Jimmy the Idiot Boy** - Jimmy is an incredibly stupid teenage boy.





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Slide 4, Image 1 (left): Please see obituary and photograph of Alex Anderson at http://www.nytimes.com/2010/10/26/arts/television/26anderson.html?_r=1&ref=obituaries.

Slide 4, Image 2 (right): Image of Rocky and Bullwinkle removed.

Slide 7: A. E. Evrard, University of Michigan

Slide 8, Quote (left): Lawrence Roberts and Barry Wessler, *Computer Network Development to Achieve Resource Sharing*, 1970, pg 543.

Slide 8, Image (right): <http://som.csudh.edu/fac/press/history/arpamaps/f7dec1970.jpg>

Slide 9: Source Undetermined

Slide 10: Source Undetermined

Slide 11: Janet Abbate, *Inventing the Internet*, MIT Press, 1999, pg. 128.

Slide 12: Janet Abbate, *Inventing the Internet*, MIT Press, 1999, pg. 150.

Slide 13: Janet Abbate, *Inventing the Internet*, MIT Press, 1999, pg. 161.

Slide 14: Source Undetermined

Slide 16: MERIT 1989

Slide 18: Please see article and pictures regarding *The Goddamn George Liquor Program* at http://en.wikipedia.org/wiki/The_Goddamn_George_Liquor_Program

Slide 19: CC:BY-NC-ND, History of Firefox and Mozilla at www.foxkeh.com/downloads/history/history-original.pdf.