Forks: Decisions that got us the Internet we have

Scott Bradner

2020-06-25

1

Not Foreseen

- The Internet of today was not anything that the technologists and planners at the start imagined
- We got here by thousands of small and some big choices
  Note choices do not always mean deciding to do something
- A few of of these were key to creating the 'Net of today
- Few of which were seen as such when they were made
- A bit U.S. centric
- Here is my set of key choices for the Internet
  It is unlikely to be anyone else's

We are our choices.

Jean-Paul Sartre

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Today's Internet

- Underpins essentially all forms of electronic communications
- 59% of world's population (4.57 billion people)
- 1.7 billion websites
- Little governance
- Little regulation
- Dynamic innovation
- Challenge to business & social order
- Made "work at home" & "study at home" feasible for many organizations

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Two Layers

Political	P/F Layer
Financial	
Application	Techie Layer
Presentation	
Session	
Transport	
Network	
Link	
Physical	

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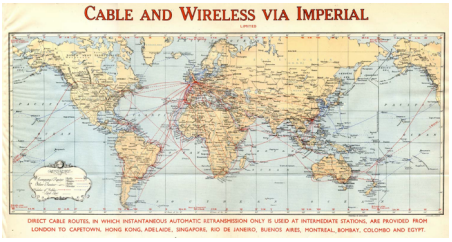
Support existing networks



1947

- Early 1970s
- Did not want to have to build a new physical network
- Also did not want to be limited to a single network or only to known existing types of networks – support new types in the future
- Required being able to deal with networks under different administrative boundaries
- This meant defining a simple definition for the small amount of required network functionality

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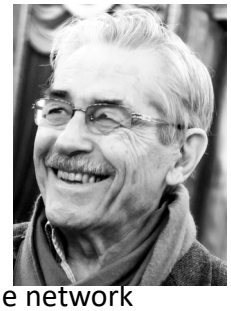
Make it Datagram-based



Louis Pouzin

- Early 1970s
- Datagram: chunk of data transported across a data network
  - Includes addressing information and (usually) a payload
  - No assumptions of a reliable network, in-order delivery or state in the network
  - Name & concept from Louis Pouzin partially based on work by Donald Davies
  - Cerf & Kahn adopted concept for TCP/IP
- Lack of network state (e.g. virtual circuit) means can reroute around failures (failure recovery)
- Building block for different types of services
- Minimizes required network functionality

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Create a Router Device

- Mid 1960s
- Separate store & forward device to interconnect physical networks
- Off load routing complexity from host to special purpose device
  Host not required to know network topology
- Split network and host management

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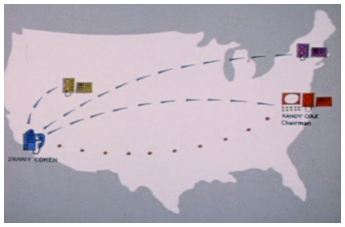
Split TCP and IP

ARPANET conference call video 1978



- ~1975
- Original Cerf/Kahn proposal was ITCP (Internet Transmission Control Program)
- Provided a reliable delivery service
- Danny Cohen, David Reed, John Shoch, Jon Postel & Cerf decided to split the delivery and the reliability parts to support real time traffic
- Result: Transmission Control Protocol (TCP) and Internet Protocol (IP) with User Datagram Protocol (UDP)
  Moved reliability responsibility out of the network into the end nodes

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End-to-end principle

END-TO-END ARGUMENTS IN SYSTEM DESIGN

J.H. Saltzer, D.P. Reed and D.D. Clark*

M.I.T. Laboratory for Computer Science

- A result, not a decision in itself
- Natural result of Pouzin's datagram concept
- Do not do things in network that are better done in the end nodes
- Splitting TCP & IP meets this principle
  IP supports datagram transport and TCP, in the end nodes, provides reliability
- Network stays "simple" ("stupid")
- Enables permissionless innovation
- No requirement to convince network operator to make a change

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CCITT turn down TCP/IP

- 1976/77
- Cerf & Kahn offered TCP/IP to CCITT (ITU-T predecessor)
- Offer turned down
  'we have X.25 and that is all anyone will ever need'
- CCITT wanted to put the applications 'in the network' (carrier model)
- CCITT & ISO worked together starting in 1978 to create the Open Systems Interconnect (OSI) protocol suite
  OSI largely assumed a carrier model

CCITT: Consultative Committee for International Telephony and Telegraphy
ISO: International Organization for Standardization
ITU-T: International Telecommunication Union-Telecommunication Standardization Sector

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DARPA fund Berkeley to add TCP/IP to UNIX

- 1981-83
- Full TCP/IP protocol suite and network applications made inexpensively available
  - Much cheaper than developing a new protocol suite
- TCP/IP became default networking protocol for new computers
- Now in just about all electronic devices
  - Even refrigerators and toasters
- Same tried for OSI in EU much later
  - But vendor backed out at the last minute

Political
Financial
Application
Presentation
Session
Transport
Network
Link
Physical

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CSNET and CSNET/ARPANET deal

- 1983
- Permitted institutions getting CSnet via ARPANET to open ARPANET email access to all faculty, students and staff
- Start of generations of students who understood networking concept
- Demanded access when they graduated and got jobs
- Later augmented by NSF Connections Program

1982
CSNET Status
Peter Denning

COMPUTER SCIENCE RESEARCH NETWORK GOALS

- Open to all computer researchers.
- Logical net comprising physical subnets (initially ARPANET, Telenet, Phonenet).
- Advanced network services (initially mail, file transfer, remote login, name server).
- Self-governing, -sustaining, and -supporting
- Low entry fee

DUES FOR CALENDAR 1983

Industry site -- $30,000
Government site -- $10,000
Non-Profit site -- $10,000
University site -- $5,000

Note: Sites with a very small number of researchers can negotiate lower dues.

FIGURE 1: Goals and Dues Structure of CSNET.

Political
Financial
Application
Presentation
Session
Transport
Network
Link
Physical

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Ignore Melbourne Treaty

Cover – 1988 Melbourne Treaty

- 1988
- ITU meeting defined a set of “international telecommunications regulations” defining a “regulatory framework” for future data networks
  - Carriers should provide leased lines to provide data services (i.e. Internet)
  - Government should oversee Internet service and providers
    - e.g., ensure basic security using *Secure Data Network System Access Control*
    - e.g., ensure quality of service &
    - e.g., establish international routes & accounting rates
- Ignored by the U.S., other than leased lines

  Everything was left to the "Information Superhighway" and constant anarchy of an unfettered marketplace. It indeed brought about almost 30 years of cyber chaos to produce what exists today.

  Tony Rutkowski 2020-06-22

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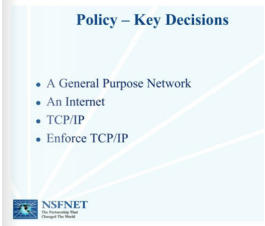
NSFNET require only TCP/IP on NSFNET

- 1986-1995
- Many network protocols in use in late 1980s

  TCP/IP, DECNet, Appletalk, IPX, XNS, …
- NSF requirement forced vendors to add TCP/IP support if they did not have it and wanted to sell to research institutes
- Suppressed demand for alternate network protocols

2007
NSFNET lookback
Dennis Jennings



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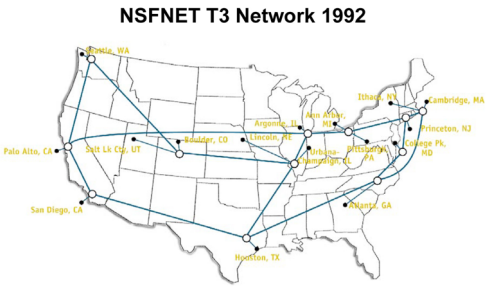
NSFNET Acceptable Use Policy (AUP)

- 1986-1992
- NSFNET AUP banned “commercial traffic”
- Enabled development of commercial Internet service providers
- Allowed NSF to turn off NSFNET in 1995



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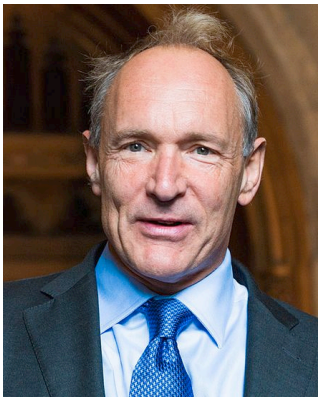
Web for free

- 1991
- Tim Berners-Lee developed the world wide web protocols and software
- Provided the protocol specifications for free
- Provided the software for free
- Did not patent any aspect



Tim Berners-Lee

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Void GOSIP Mandate

National Institute of Standards and Technology

[Docket No. 950215052–5052–01]

Approval of Federal Information Processing Standards Publications (FIPS) 146–2, Profiles for Open Systems Internetworking Technologies, and 179–1, Government Network Management Profile

Federal Register
May 15, 1995

- 1995
- Many governments mandated support for OSI protocols
  - Including the US government
  - Developed GOSIP, a subset of OSI that was required to be supported
- OSI seen as The Future (even by some people in the IETF)
- Long wasteful and bitter conflict between TCP/IP & OSI supporters
- Until US government adopted FIPS 146-2
  - *In addition, other specifications based on open, voluntary standards, such as those cited in paragraph 3* [IETF, ISO, ITU-T] *may be used.*

GOSIP: Government Open Systems Interconnection Profile

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Minimal regulation

- 1983-present
- Internet escaped the kind of regulation that applies to the telephone world
- No price controls, no application pre-approval, no required function list
- Lets a thousand applications bloom

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Section 230


Chris Cox


Ron Wyden

- 1996
- Section 230 of the Communications Decency Act (CDA) of 1996

  (1) No provider or user of an interactive computer service shall be treated as the publisher or speaker of any information provided by another information content provider.

  (2) No provider or user of an interactive computer service shall be held liable on account of—

  (A) any action voluntarily taken in good faith to restrict access to or availability of material that the provider or user considers to be obscene, lewd, lascivious, filthy, excessively violent, harassing, or otherwise objectionable, whether or not such material is constitutionally protected; or

  (B) any action taken to enable or make available to information content providers or others the technical means to restrict access to material described in paragraph (1).
- The only reason that Facebook, YouTube, Twitter, etc. exist
- Under attack

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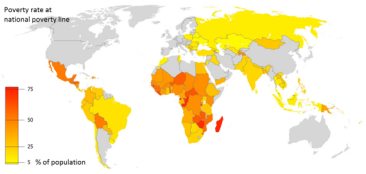
Some of the Challenges



Poverty rate World Bank - 2012

- Connecting the "next billion" people (rich/poor divide)
- Dominance of a few service providers (Google, Amazon, etc.)
- Continuing push for governance – to "protect" society
- Continuing push for regulation – to "protect" kids, users & businesses
- Continuing push for encryption backdoors – to make law enforcement easy
- Continuing push for carrier model (e.g. 5G & NewIP)

  i.e., preserving ability for individuals to innovate
- Need to reimagine business models

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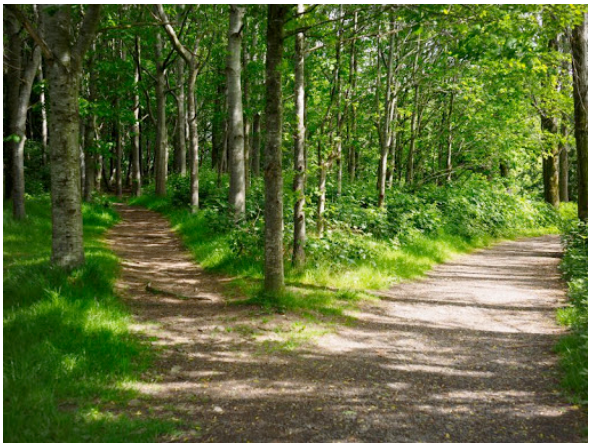
Less traveled by

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

Robert Frost, *The Road Not Taken*



Melanie Bowes

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Thank You

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