Visionaries, Builders & Now:
The Internet from before to now

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Fairwind Partners

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Internet pre-history, history & status

1957-present

- A series of people and events that got us to today's Internet
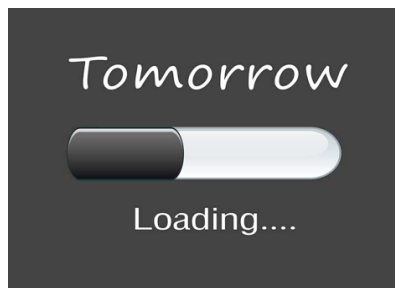- Representative, not comprehensive

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Visions

Visions of a networked future

- Scientists, science fiction writers and others imagined what a networked future would look like long before one existed
- Here are a few examples
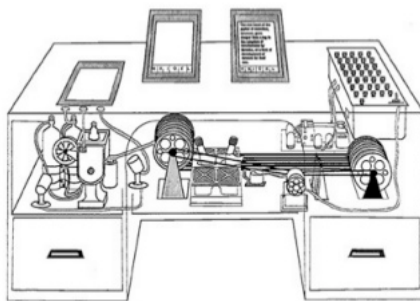
1945: Vannevar Bush

Vannevar Bush

- American engineer, inventor and science administrator,
- Headed the U.S. Office of Scientific Research and Development (OSRD during World War II
  Office supported most US wartime military R&D
  Office started Manhattan Project
- Understood that the future was all about data

## 1945: Bush: *As We May Think*

Bush's *memex*

Wholly new forms of encyclopedias will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the memex and there amplified. The lawyer has at his touch the associated opinions and decisions of his whole experience, and of the experience of friends and authorities. The patent attorney has on call the millions of issued patents, with familiar trails to every point of his client's interest. The physician, puzzled by a patient's reactions, strikes the trail established in studying an earlier similar case, and runs rapidly through analogous case histories, with side references to the classics for the pertinent anatomy and histology.
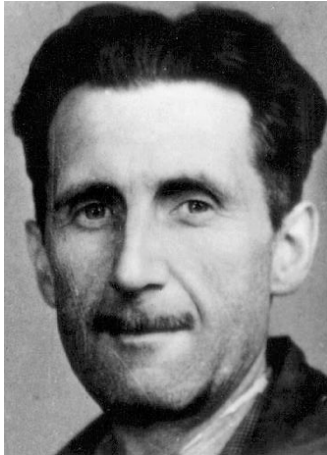
1949: George Orwell

George Orwell

- English journalist, novelist, and political writer
- Known for dark views of society, present and future

7 Copyright © Scott Bradner 2018

1949: Orwell: *1984*

BIG BROTHER IS WATCHING YOU

How often, or on what system, the Thought Police plugged in on any individual wire was guesswork. It was even conceivable that they watched everybody all the time. But at any rate they could plug in your wire whenever they wanted to. You had to live -- did live, from habit that became instinct -- in the assumption that every sound you made was overheard, and, except in darkness, every movement scrutinized.

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1963: J.C. R. Licklider

J.C.R. Licklider

- MIT Psychology Department
  - Helped set up Lincoln Laboratory
- Worked at BBN starting in 1957
  - One project was "Libraries of the Future"
- Moved to ARPA in 1962
  - Led Behavioral Science Command and Control Research

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1963: Licklider: *Intergalactic Computer Network*

The major point of his memorandum is that the establishment of network of computers is difficult with the technology they know and have. At this time computers were mainly used by government and academia, so this was a "military problem". So many computers ran on so many different languages it would be hard to establish a network. A common language or a method of translating languages from one computer to another was needed.

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1967: Philco-Ford: *Year 1999 A.D.*

- She: home shopping
  Select wares by push button
- He: paying her bills
  Electronic bill paying
- Household monitor
  Spy on kids at swimming pool
- Household records
  Access through console
- Electronic correspondence
  Instant written communication to anyone anywhere in world

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1975: John Brunner
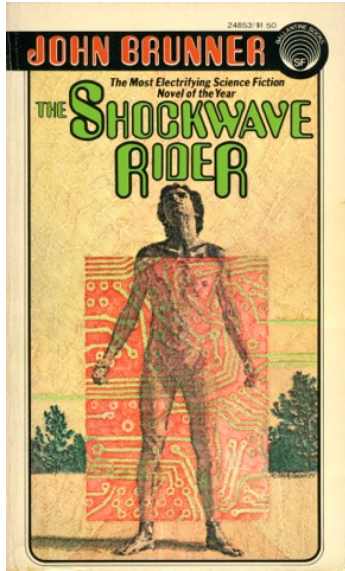
John Brunner

- English science fiction writer
- Wrote about 60 science fiction books

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1975: John Brunner

Three hundred million people with access to the integrated North American data-net is a nice big number of potential customers.

Ah, you don't have to know anything. You just need to know where to find it
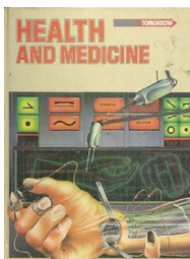
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1981: Neil Ardley

Neil Ardley

- English jazz composer and author of informative books for young people
- Big band and New Orleans style jazz
- Worked for *World Book Encyclopedia*
- Wrote books on technology
  e.g. The Way Things Work
  e.g. The World of Tomorrow

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1981: Neil Ardley

People still collect books as valuable antiques or for a hobby, but you get virtually all the information you need from the viewscreen of your home computer system. The computer is linked to a library - not a library of books but an electronic library where information on every subject is stored in computer memory banks. You simply ask.

Instead of going out to shops and stores in your town or city, you contact them through your videophone computer. You'll need to see what you are buying, even if you can't handle it, so the viewscreen of the videophone computer shows you the goods available. You then instruct the computer to order the goods you want and have them delivered to your house.

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Kickoff

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Internet history: Sputnik
1957
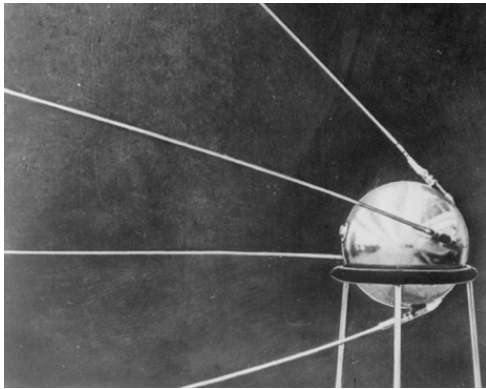
- 4 October 1957
- 1st man made satellite
- Launched by Soviet Union
- Caused *hysteria*
  Roger Launius *Sputnik and the Origins of the Space Age*
- *The sky seemed almost alien*
  Lyndon B. Johnson

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Internet history: Dwight David Eisenhower
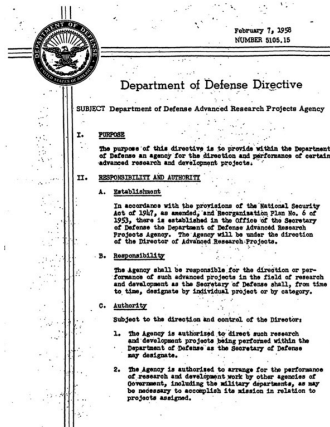### 1958

Dwight David Eisenhower

- U.S. President – 1953-1961
- January 1958: Eisenhower, following advice from his science advisor Jim Killian, reacted to Sputnik by establishing the *Advanced Research Projects Agency* (ARPA) within the U.S. Department of Defense

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ARPA Mission

February 7, 1958
NUMBER 5105.15

Department of Defense Directive

SUBJECT Department of Defense Advanced Research Projects Agency

I. PURPOSE
The purpose of this directive is to provide within the Department of Defense an agency for the direction and performance of certain advanced research and development projects.

II. RESPONSIBILITY AND AUTHORITY

A. Establishment
In accordance with the provisions of the National Security Act of 1947, as amended, and Reorganization Plan No. 6 of 1953, there is established in the Office of the Secretary of Defense the Department of Defense Advanced Research Projects Agency. The Agency will be under the direction of the Director of Advanced Research Projects.

B. Responsibility
The Agency shall be responsible for the direction or performance of such advanced projects in the field of research and development as the Secretary of Defense shall, from time to time, designate by individual project or by category.

C. Authority
Subject to the direction and control of the Director:

1. The Agency is authorized to direct such research and development projects being performed within the Department of Defense as the Secretary of Defense may designate.

2. The Agency is authorized to arrange for the performance of research and development work by other agencies of Government, including the military departments, as may be necessary to accomplish its mission in relation to projects assigned.

- Official:

  The Agency shall be responsible for the direction or performance of such advanced projects in the field of research and development as the Secretary of Defense shall, from time to time, designate by individual project or by category.[1]

- Actual?:

  to prevent technological surprise like the launch of Sputnik[2]

1: http://semanticvoid.com/docs/darpa_directive.pdf
2: http://www.dtic.mil/cgi-bin/GetTRDoc Location=U2&doc=GetTRDoc.pdf&ADA433949 *DoD Directive No. 5105.15* http

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Builders

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Internet history: J.C.R Licklider

1960-68

J.C.R Licklider

- 1962: argued for, created & initially led the ARPA Information Processing Techniques Office (IPTO)

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Internet history: Paul Baran
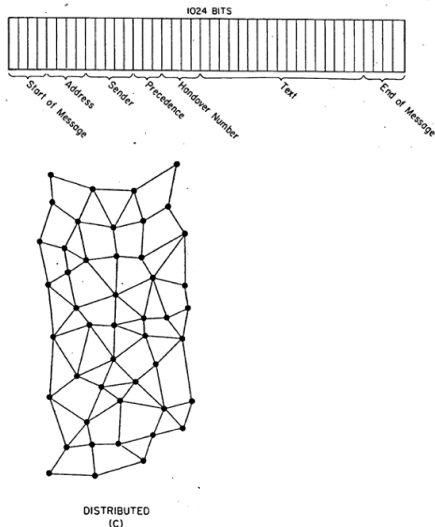
1960-64

Paul Baran

- Hughes Aircraft & RAND Corp.
  Funded by US Air Force
- 1960: *Reliable Digital Communications Systems Using Unreliable Network Nodes*
  Reliability through redundancy
- 1962: *On Distributed Communications Networks*
  Basic concepts of packet switched networks

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Internet history: Paul Baran, contd.

1960-64

1024 BITS

Start of Message · Address · Sender · Precedence · Handover Number · Text · End of Message

DISTRIBUTED
(C)

- "standardized message block"
  Source & destination addresses
  Precedence (QoS)
  Payload
- Distributed network
  Switching nodes (routers)
  Store and forward
  Redundant paths for reliability
  Shortest-path hot-potato routing protocol
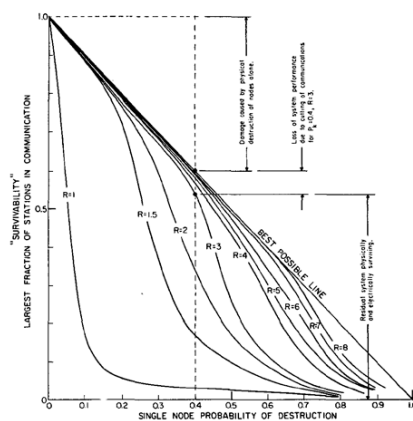
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Internet history: why message blocks

1962-64

Fig. 4—Perfect switching in a distributed network: sensitivity to node destruction, 100 per cent of links operative.

- Communication at the time was circuit-based
- Circuit setup takes too much time relative to transmission length as links get faster
- Message-based networks also provide:
  Multiplexing of different rate communications
  Minimal message retransmission after failover to new routes
  Resilience in the face of failure
  Support for many applications
     (including speech)

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Baran's Goal[1]

It Looks Darling!

Courtesy Herblock in The Washington Post

- Develop a command and control network that could survive a first strike nuclear attack
- Make design public so Russia would have it
  - Almost all of Baran's documents were pubic
- AT&T: it will not work
- Did not get built
  - DCA would have had to do it

1: https://conservancy.umn.edu/handle/11299/107101

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Internet history: Donald Davies

1966-70

Donald Davies

- U.K. National Physical Laboratory
- 1966: proposed "packet" based communication between computers
  - Later introduced to Baran's work
- 1967: Roger Scantlebury (from Davies's group) presented paper on packet switch networks
  - Larry Roberts in audience
    - Afterward Scantlebury reminded Roberts about Baran's work

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Internet history: Robert (Bob) Taylor

1965-66

Bob Taylor

- Took over ARPA IPTO in 1965
- 1966: requested & was authorized to spend $1M to build a data network to enable remote access to ARPA-funded timeshare computers
- 1966: Appointed Lawrence (Larry) Roberts to manage network project, which became the ARPANET

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ARPANET Mission

Resource Sharing Computer Networks

The objective of this program is twofold:

(1) To develop techniques and obtain experience on interconnecting computers in such a way that a very broad class of interactions are possible, and

(2) To improve and increase computer research productivity through resource sharing.

By establishing a network tying IPT's research centers together, both goals are achieved. [1]

1: https://archive.org/stream/ResourceSharingComputersNetworks3/AAPA.txt

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Internet history: Lawrence (Larry) Roberts

1966-73
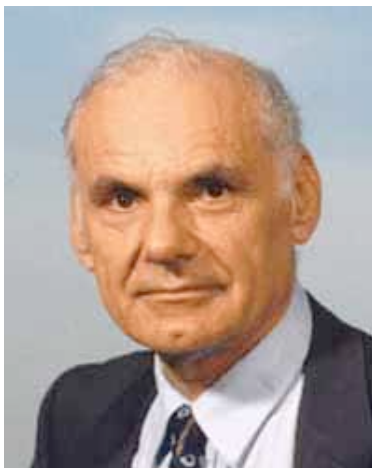
Larry Roberts

- Decided to offload network processing to separate computers
  - (Idea from Washington University physicist Wesley A. Clark)
    - Interface Message Processor (IMP)
- Decided did not want to use circuit switched networks
- Adopted packet switching for the ARPANET after 1967 meeting
- Took over ARPA IPTO in 1969

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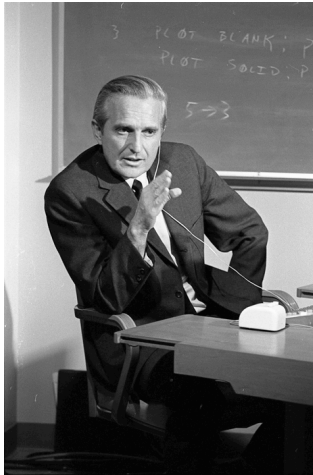## Internet history: Leonard (Len) Kleinrock

1968

Len Kleinrock

- UCLA professor of computer science
- 1963: MIT thesis on queuing theory
  - Used in understanding operation of packet switches
- First ARPANET message sent from Kleinrock's UCLA lab

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Internet history: Douglas Engelbart

1968

Douglas Engelbart

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- Stanford Research Institute
- Founded ARPA funded Augmentation Research Center
- 1968: Mother of all Demos[1]
  - computer mouse
  - windows
  - Real-time editing
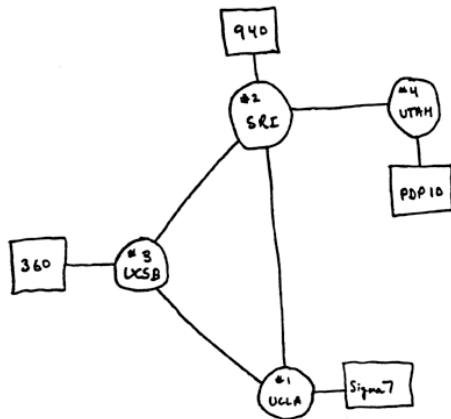 - bitmapped screens
  - hypertext
  - . . .

1: https://www.youtube.com/watch?v=yJDv-zdhzMY

The pre-Internet & the Internet

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Internet history: ARPANET

1969

- First 4 nodes installed
  - UCLA – Len Kleinrock
  - Stanford Research Institute – Doug Engelbart
  - University of California, Santa Barbara – Glen Culler and Burton Fried
    - Early interactive on-line system
  - University of Utah – Ivan Sutherland

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Internet history: ARPANET, contd.

1970-80
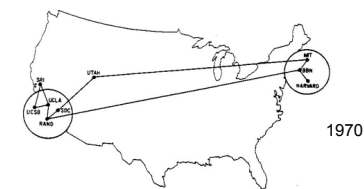
1970

ARPANET GEOGRAPHIC MAP, OCTOBER 1980

1980

- 1970 – east coast
  First MIT, then Harvard
  9 hosts
- 1973 – International
  Norway & London
  22 hosts + 18 TIPs
    TIPs supported terminals
- 1980 – 200 hosts
  20,000 users

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Internet history: Robert (Bob) Kahn
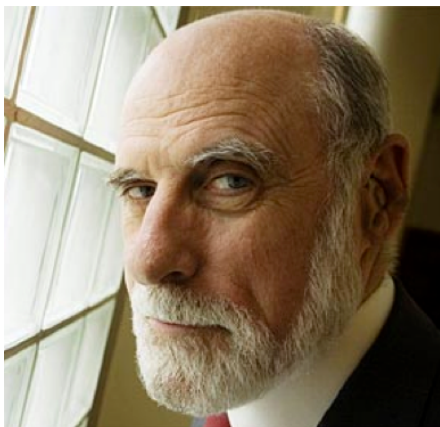
1968-76

Bob Kahn

- 1964: PhD from Princeton explored sampling theory
- 1968: Joined BBN & worked on IMP
- 1972: moved to ARPA IPTO
- Late 1972: organized demonstration ARPANET communications (20-nodes)
- 1973: asked Vint Cerf to help design a new communications protocol for the ARPANET

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Internet history: Vinton (Vint) Cerf

1973-81

Vint Cerf

- Kahn realized that just interconnecting hosts over a single network did not scale
  - Needed a way to interconnect hosts on different networks
- He asked Vint Cerf for help
- They took into account the design of the CYCLADES network

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Internet history: TCP/IP – the start of the Internet itself

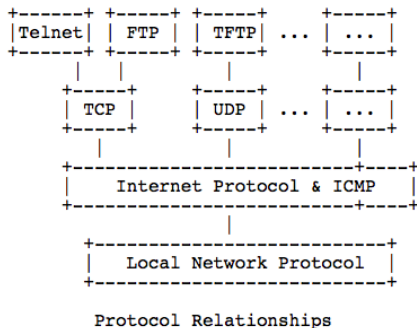### 1974-81

Protocol Relationships

Figure 1.

TCP/IP

- 1980 & 81: Internet Protocol, Transmission Control Protocol & User Datagram Protocol

  Provided both reliable and unreliable services

  Added UDP in parallel to TCP

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What did *they* think the Internet was?

- Irrelevant

  Only a "research network"

  No guarantees, no security

- Result: no regulations

  Key enabler

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Internet history: commercialization

1990-

- Pre 1991: commercial use of ARPANET & NSFNET banned
- 1990: commercial ISPs formed
- 1991: Commercial Internet eXchange (CIX) formed
- 1991: limited commercial use of NSFNET permitted
- 1992: MAE-East formed
- 1995: NSFNET closed
    U.S. government out of backbone business

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Internet history: the web

1991-

Tim Berners-Lee

http://www.internetlivestats.com/total-number-of-websites/

- 1991: Tim Berners-Lee releases web browser and server
- 1991: first web sites
- 1993: NCSA Mosaic released
- 1994: Netscape browser
- 1995: 23 K web sites
- 2000: 17 M web sites
- 2005: 65 M web sites
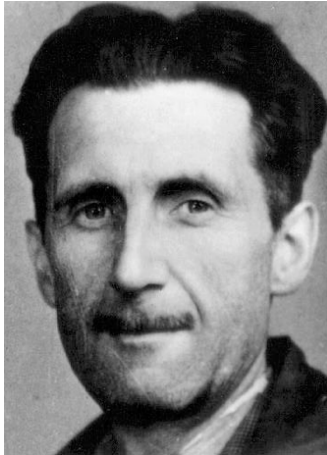- 2010: 200 M web sites
- 2015: 1 B web sites

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Linking Back

1945: Vannevar Bush

Vannevar Bush

- Its all about finding patterns in data
  "big data"

1949: George Orwell

George Orwell

- Big Brother watches all

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1963: J.C. R. Licklider

J.C.R. Licklider

- The Internet is not quite intergalactic but is covers this planet and some of the near space around it

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1967: Philco-Ford: *Year 1999 A.D.*

- Home shopping, bill paying, network-based video surveillance and email (or at least spam) have taken over the world

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1975: John Brunner

John Brunner

Ah, you don't have to know anything. You just need to know where to find it

- Describes learning in the age of Google

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1981: Neil Ardley

Neil Ardley

- His vision of home shopping, more detailed than Philco Ford's, network-based libraries as well as his many other visions are what we see around us today

Summary

- The Internet met the early visions
- And so much more
- The widespread disruption of society and business was not predicted
- Predicting what comes next is beyond me